FIMR

MERI

Report Series of
the Finnish Institute of Marine Research

No. 62
2008

FIMR MONITORING OF THE BALTIC SEA ENVIRONMENT — ANNUAL REPORT 2007

Riitta Olsonen (Editor)

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Copies of this Report Series may be obtained from the library of the Finnish Institute of Marine Research.

Tämän raporttisarjan numeroita voi tilata Merentutkimuslaitoksen kirjastosta.

ISSN 1238-5328
ISBN 978-951-53-3034-5 (nid.)
ISBN 978-951-53-3035-2 (PDF)

CONTENTS

FIMR MONITORING OF THE BALTIC SEA ENVIRONMENT – ANNUAL REPORT 2007

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PREFACE

This report describes the state of the Baltic Sea and its sub-basins in 2007, based mainly on observations by FIMR. The report from last year was the first in FIMR's new series of annual reports. This time the general summary is more extensive and for each sub-basin the most important changes are also detailed. The summary is in Finnish, Swedish and English; in addition, fact boxes and figure legends in the subsequent English chapters are presented in Finnish and Swedish as well.

Acknowledgements

We owe greatly to our colleagues at FIMR who have in many ways contributed to this report, but are too many to be individually mentioned here.

Especially we want to give our best compliments to Leena Parkkonen and Leena Roine, who with their efficient and competent work made this report possible. Equally, we like to express our gratitude to our excellent translators, Ann-Britt Andersin and Joanna Norkko, as well as our outstanding language consultant Robin King.

ESIPUHE

Tässä raportissa kuvataan Itämeren ja sen eri osien tilaa vuonna 2007 pääosin Merentutkimuslaitoksen havaintojen pohjalta. Muutoksena viimevuotiseen, Merentutkimuslaitoksen uuden vuosiraporttisarjan ensimmäiseen, on yhteenvetoa laajennettu ja tarkennettu eri merialueille. Yhteenveto löytyy sekä suomeksi, ruotsiksi että englanniksi; lisäksi englanninkielisten artikkelien kuvatekstit ja tietolaatikot ovat myös sekä suomeksi että ruotsiksi.

Kiitokset

Haluamme esittää kiitoksemme kollegoillemme Merentutkimuslaitoksessa, jotka monin tavoin ovat myötävaikuttaneet tämän raportin tekemisessä, mutta joita on liian monta tässä lueteltaviksi.

Erityiset kiitoksemme haluamme antaa Leena Roineelle ja Leena Parkkoselle, jotka mahdollistivat tämän raportin tehokkaalla ja asiantuntevalla panoksellaan.

Samaten haluamme ilmaista kiitollisuutemme erinomaisille kielenkääntäjillemme Joanna Norkolle ja Ann-Britt Andersinille sekä tarkalle ja ystävällisen kärsivälliselle kielentarkastajallemme Robin Kingille.

FÖRORD

I denna rapport beskrivs Östersjöns och dess olika delars tillstånd år 2007, baserat främst på Havsforskningsinstitutets observationer. Förra årets rapport var den första i Havsforskningsinstitutets nya serie av årsrapporter. I år är det allmänna sammandraget mera omfattande och innehåller även en mera detaljerad beskrivning av tillståndet i de olika havsområdena. Sammandraget finns på svenska, finska och engelska. Dessutom presenteras figurtexterna och faktarutorna i de engelska artiklarna även på finska och svenska.

Tack

Vi vill tacka våra kollegor vid Havsforskningsinstitutet som har bidragit till denna rapport på många sätt, men som är för många för att nämnas individuellt. Vi vill särskilt tacka Leena Parkkonen och Leena Roine, vilkas effektiva och kompetenta insatser gjorde rapporten möjlig. Vi vill även framföra vårt tack till våra översättare Ann-Britt Andersin och Joanna Norkko, samt vår utmärkta språkkonsult Robin King.

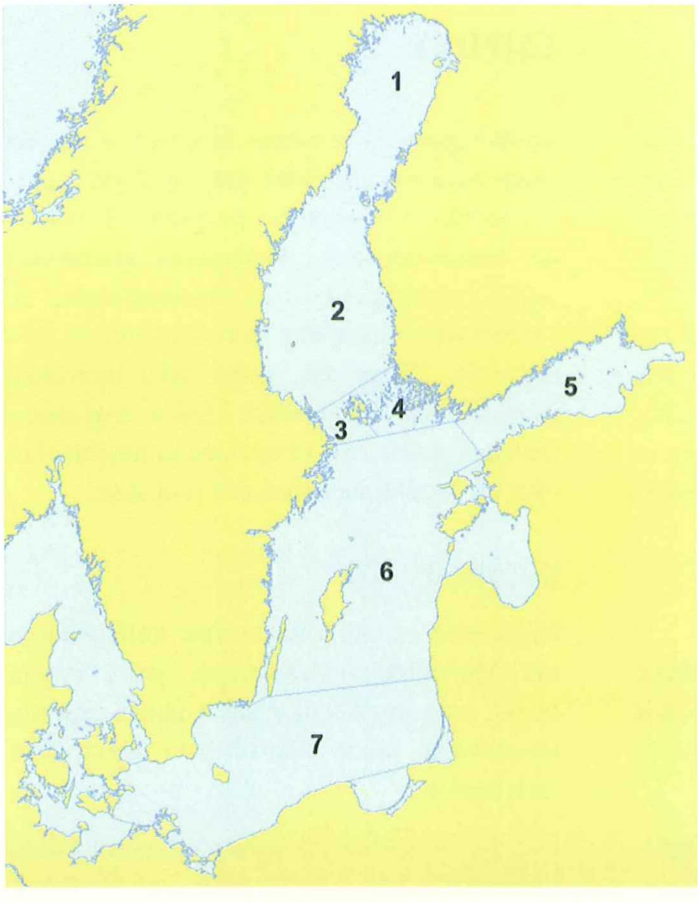


Fig. 1. Different sea areas of the Baltic Sea referred to in the text:

Kuva 1. Tekstissä esiintyvät Itämeren alueet:

Bild 1. Österjöns olika havsområden som refereras till i texten:

1 Gulf of Bothnia: Bothnian Bay	Pohjanlahti: Perämeri	Bottniska Viken: Bottenviken
2 Gulf of Bothnia: Bothnian Sea	Pohjanlahti: Selkämeri	Bottniska Viken: Bottenhavet
3 Åland Sea	Ahvenanmeri	Ålands hav
4 Archipelago Sea	Saaristomeri	Skärgårdshavet
5 Gulf of Finland	Suomenlahti	Finska viken
6 Northern Baltic Proper	Pohjoinen varsinainen Itämeri	Norra egentliga Östersjön
7 Southern Baltic	Eteläinen Itämeri	Södra Östersjön

SUMMARY

General

The average **sea level** was exceptionally high along the Finnish coastline in January 2007, about 50 cm above the long-term average, and was at its highest in the middle of the month. In the Gulf of Finland and in the Archipelago Sea, the sea level was higher than normal for unusually long. During the rest of the year the sea level was 5–25 cm above average, except in June when it was about 5 cm lower and in October when it was about average.

Waves were measured in the Gulf of Finland and in the Northern Baltic Proper. In these areas the waves were higher than normal in January, April, July, September and December. In February and October the sea was calmer than normal.

The **ice season** of 2006–2007 was mild. Air temperatures were exceptionally high in December and March. Only February was cold in the north. The first ice developed at the beginning of November, but only towards the end of January did the sea begin to freeze to any larger extent. The maximum extent of the ice cover was reached in late February, when the ice covered 33% of the Baltic Sea. The duration of the ice season was around average in the northern Bothnian Bay, but over a month shorter than average in the southern Bothnian Bay and a month and a half shorter than average in other sea areas. In the Baltic Proper no ice occurred at all.

In general, Baltic Sea **temperature, salinity and oxygen conditions** were around average. The temperatures of Finnish coastal waters were about normal for most of the year. Nevertheless, the beginning of January was clearly warmer than normal and a colder than normal period occurred in July. Sea surface temperatures were highest in mid-August. Near-bottom oxygen concentrations in the northern Bothnian Sea were comparatively low in late summer. In the Gulf of Finland the waters were to a large extent mixed down to the bottom in the 2006–2007 winter. There were no major saline pulses into the Baltic Sea in 2007.

Phytoplankton blooms: The spring bloom in the Gulf of Finland formed a week earlier than normal, reaching its usual level at the beginning of April and declining about two weeks earlier than normal. The first cyanobacteria blooms were observed already in mid-June in the eastern Gulf of Finland and south of the Åland Islands. The blooms consisted of non-toxic *Aphanizomenon*-cyanobacteria. The summer bloom reached its peak at the beginning of July and was twice as high as normal. At the time of the summer maximum cyanobacteria made up only 1/3 of the biomass, while 2/3 of the biomass consisted of other algal groups. Weather conditions in July remained cool and windy, and thus only occasional, scattered cyanobacterial blooms occurred in the Gulf of Finland, the Archipelago Sea, the Åland Sea and along the coast. At the beginning of August, on the other hand, large surface blooms occurred in the Gulf of Finland, the Åland Sea, the Archipelago Sea and even in the Bothnian Sea due to the warm weather and the upwelling that had occurred in July. Abundant blooms also occurred along the coast. After the surface waters had warmed up, the relative proportion of the toxic *Nodularia spumigena* increased in the surface blooms. The accumulations were dispersed by the wind, but algae remained mixed into the water until the end of August.

The **zooplankton** monitoring data from different sea areas indicates clear trends of change since the observations started in 1979. In the Gulf of Bothnia zooplankton biomass has increased and abundances of trophically important species have remained stable. In contrast to the Gulf of Finland and the Baltic Proper, the ecosystem of the Gulf of Bothnia does not suffer from anoxic deep-water, and this facilitates access also to deeper water layers, which is important for many zooplankton species. In the Baltic Proper and the Gulf of Finland especially the neritic copepod *Pseudocalanus acuspes* has decreased dramatically. Also the neritic cladocerans *Podon* and *Evadne* have decreased. Other crustacean zooplankton, like the copepods *Acartica*, *Temora* and *Eurytemora*, have increased in these sea areas.

A new **invasive species**, the American comb jelly *Mnemiopsis leidyi*, arrived in our waters during 2007. During monitoring cruises in summer 2007 the species was observed in the western Gulf of Finland and in the northeastern Baltic Proper, and it was particularly abundant in the deep areas of the Åland Sea and the Bothnian Sea. The highest abundances reached 400–600 indviduals/m^2 in these deep areas and this is also were the largest individuals were found (approx. 15 mm long). It was discovered that the species is able to reproduce in our waters at a smaller size and in colder temperatures than previously observed in other parts of the world. It appears evident that the species has now been permanently established in the Baltic Sea. Our latest observations from the 2007–2008 winter monitoring cruise indicate that the species can survive winter conditions and that it has again increased in abundance and spread further.

Total oil concentrations in surface waters follow the trend observed in previous years; concentrations have decreased significantly from the 1990s to 2007 in nine out of twelve sampled areas. Oil concentrations are lowest in the north, but increase towards the south.

Restrictions in the emissions of **harmful organic compounds and heavy metals** have had a clear positive effect in sea areas around Finland. Concentrations of DDT- and PCB-compounds and pesticides in young herring have decreased considerably. Concentrations of organic contaminants are below safety limits for human consumptions (see Chapter 9, Table 1). Mercury and cadmium concentrations have also decreased, although not as markedly. Concentrations of mercury are even below safety limits. The general decrease in harmful substances is a positive sign of the diminishing contaminant load to the Baltic Sea. The decreasing trend in these known contaminants is one of the few positive changes in the Baltic Sea.

Gulf of Bothnia

Short-term fluctuations in the sea level were as usual strongest in the Bothnian Bay. In January the highest sea level along the Finnish coast in 2007 was measured in Oulu (+166 cm) and a local record level was reached in Rauma (+123 cm). Local records for the month of May were measured in Raahe (+57 cm), Pietarsaari (+54 cm) and Vaasa (+47 cm), and for April a local record was measured in Vaasa (+63 cm).

Although the first ice developed around the usual time in early November, a mild period commenced at the end of November and lasted until the end of January. The Bothnian Bay did not freeze until the beginning of February, about three weeks later than normal. The Bothnian Sea did not gain a complete ice cover at any time during the winter, and became ice free at the beginning of April, about two weeks earlier than normal. The Bothnian Bay became ice free around the usual time in late May.

Surface temperatures were warmer than average in June, but at the end of the month the waters cooled markedly and temperatures were much below average until the end of July. The surface waters were warmest around mid-August. In autumn temperatures were normal.

In recent years, oxygen conditions in the deep waters of the Bothnian Bay and Bothnian Sea have slowly deteriorated. However, there is still generally sufficient oxygen in the near-bottom waters, even though concentrations in the northern Bothnian Sea have reached alarmingly low levels on a few occasions.

Nutrient concentrations have in general remained rather stable in the Gulf of Bothnia, although both nitrate and phosphate concentrations have increased slightly in the Bothnian Sea over the last few years.

In the Gulf of Bothnia, there are signs that abundances of the amphipod *Monoporeia affinis* are recovering after a decade of decline. The invasive polychaete *Marenzelleria* sp. has continued to spread in the Bothnian Sea, although their abundances have declined somewhat.

Composition and biomass of the phytoplankton community in late summer were typical for the area. In the Bothnian Bay, the phytoplankton community mainly consisted of small flagellated algae (prasino-, hapto- and chrysophytes). *Mesodinium rubrum* also formed a remarkable proportion of the biomass. In the Bothnian Sea, small flagellated algae, mainly chryso- and haptophytes dominated phytoplankton abundance and biomass. The relative proportion of biomass contributed by bloom-forming filamentous cyanobacteria was lower in 2007 than in 2004–2005.

The zooplankton species composition continues to develop according to the trends observed in the 1979–2006 period. The Gulf of Bothnia does not suffer from anoxic deep-water, so the species composition has not changed significantly, but in general zooplankton biomasses are increasing. The invasive American comb jelly *Mnemiopsis leidyi* has also spread to deeper waters of the Bothnian Sea and relatively high densities were recorded in both the southern and the northern parts of the Bothnian Sea.

DDT- and PCB-concentrations have decreased significantly in herring. Concentrations of pesticides are below the detection limit. Oil concentrations in surface waters are low and decreasing in the area, particularly in the Bothnian Bay. No significant changes were observed in heavy metal concentrations, although mercury concentrations in herring from the Bothnian Bay had decreased slightly in 2006 compared to the previous year. In general, heavy metal concentrations in muscle and liver of herring from the Gulf of Bothnia are low.

Åland Sea

Annual fluctuations in surface water temperatures were similar to the Gulf of Bothnia. Deep-water temperature was comparatively high, but salinity remained at a level similar to the last few years.

The Åland Sea did not freeze in the 2006–2007 winter.

Since the deep areas of the Åland Sea north of the Salpausselkä ridge do not suffer from anoxic deep water, the zooplankton species composition is fairly normal. The neritic copepod *Pseudocalanus acuspes* and the deep-water copepod *Limnocalanus macrurus* are commonly found, as are mysid shrimp, which live in near-bottom waters. The invasive American comb jelly *Mnemiopsis leidyi* was also found in very high densities in the deep areas of the Åland Sea.

Harmful organic compounds have decreased significantly in herring and heavy metal concentrations are low. Total oil concentrations in surfaces waters have clearly declined from the beginning of the 1990s to 2007.

Archipelago Sea

In mid-January the sea level was exceptionally high for longer than usual; a local annual record was measured in Föglö (+102 cm) due to a winter storm. At the end of July low air pressure and stormy winds caused a rise in sea level that was exceptional for the time of the year and a local July record was measured at Föglö (+46 cm).

The Archipelago Sea was completely ice covered in mid-February, 2–3 weeks later than normal. By mid-March the area was already partly open and the remaining ice was largely rotten. The ice melted completely at the beginning of April, about two weeks later than normal.

In summer the water was first warmer than normal, but in July it became cooler. From August until the end of the year, the water was again somewhat warmer than average. Temperatures at 30–40 m depth were higher than normal during the whole year. At the same time, deep-water salinity was considerably lower than normal.

The first surface accumulations of *Aphanizomenon*-cyanobacteria were observed by the coast guard air patrol already in mid-June. Also moderate blooms of *Nodularia* were observed in August.

FIMR does not monitor harmful substances in this area.

Gulf of Finland

In 2007 the sea level was highest in mid-January and remained high for exceptionally long, although no record levels were reached. At the end of July the sea level was higher than normal for the time of the year and a July record was measured in Hamina (+104 cm). On October 12th the sea level fell rapidly; the lowest sea level of 2007 was measured in Hamina (-80 cm).

Waves were highest in January, when a significant wave height of four meters was measured. In July the waves were higher than normal and the second highest waves of the year were measured at the end of the month (3.7 m). This was also a July record. Also in September and December the waves were somewhat higher than normal. However, waves remained below three meters, except for January and July.

First freezing occurred in the eastern Gulf of Finland in late December 2006, about three weeks later than normal. In early January the water was clearly warmer than normal. Actual ice formation did not begin until late January. The Gulf of Finland was completely ice covered in mid-February. Due to warm weather the Gulf of Finland was half open already in mid-March. The ice melted in early April, about two weeks earlier than normal.

During winter the water column was mixed down to the bottom and thus oxygen conditions were good also in the middle of the Gulf of Finland. Due to the mixing, nutrient concentrations in the surface waters were relatively high. In spring and early summer water temperatures were about normal, but in July a cooler than normal period occurred. The surface waters were warmest around mid-August and fairly normal for the rest of the year.

During spring more saline and oxygen poor water flowed from the Baltic Proper into the Gulf of Finland, causing strong stratification and poor oxygen conditions below 70 m depth. Concurrently phosphate concentrations in the near-bottom waters increased. Later in summer salinity decreased and oxygen conditions improved somewhat, but nevertheless remained poor. Unlike the last few years, hydrogen sulphide was again observed in near-bottom waters at the entrance of the Gulf of Finland. Oxygen conditions became poor in the deep areas of the Gulf of Finland already a decade ago and benthic communities subsequently declined. The situation has not improved, except for at the easternmost sampling site. The benthic fauna is still either missing completely or abundances are very low.

The phytoplankton spring bloom occurred earlier than normal in March. The summer bloom peaked at the beginning of July and was twice as intense as the long-term average. In August 2007 phytoplankton abundance and biomass were at the highest level recorded in nearly ten years. First observations of cyanobacteria were made already in mid-June in the eastern Gulf of Finland. Thereafter surface streaks were broken up by winds and the next observations were made around Midsummer in the western and eastern Gulf of Finland. In July the weather remained cool and windy, which prevented large blooms from developing; only occasional, scattered cyanobacterial blooms occurred.

The zooplankton species composition continues to develop according to the trends observed in the 1979–2006 period. Total biomasses are declining, especially regarding the neritic copepod *Pseudocalanus*. This is partly due to decreasing salinity, but is also due to secondary effects of eutrophication, such as occasional deep-water oxygen depletion.

Harmful substances are generally decreasing in herring. DDT- and PCB-concentrations in particular have decreased significantly and are clearly below safety limits for human consumptions (see Chapter 8, Table 1 for details). In general, mercury concentrations vary a lot in the Gulf of Finland, but they are fairly low and below safety limits. In the Kotka area there is, however, a slight increase in the long-term trend for mercury in herring. Pesticide residues are even below the detection limits. Total oil concentrations have been decreasing considerably in the eastern Gulf of Finland, but in the middle of the Gulf there is no clear trend. Oil concentrations are below the safety limit for polluted water.

Northern Baltic Proper

The wave climate in January was rougher than usual and the significant wave height was over two meters half the time. The highest waves, 5.4 m, were also measured in January. Also April, July, September and December were rougher than usual, while February and October were calmer than average. In October the significant wave height was below one meter for 49% of the time. The sea did not freeze in the 2006–2007 winter. Based on the few observations available, sea surface temperatures followed the patterns observed in other subbasins as well; the water was slightly warmer than normal except for a cooler period in July. Also deeper waters were slightly warmer than normal. Surface salinity was lower than average, while deep-water salinity was higher than average. Thus the stratification was stronger than normal. The saline pulse in 2003 can still be detected in the deep waters.

Hydrogen sulphide occurs on the deep bottoms and they are devoid of benthic macrofauna. Nutrient concentrations have not changed markedly.

The spring bloom peaked at the normal time in April and was somewhat higher than the long-term average. The summer peak was reached already in early June and it was twice as high as normal. 1/3 of the biomass of the bloom was formed by cyanobacteria, while the unusually high biomass of other algal groups contributed the rest.

Based on the annual monitoring in August, the phytoplankton biomass in 2007 was the highest observed in the 2001–2007 period. Dinoflagellates and bloom-forming cyanobacteria together made up the main part of the algal biomass. Based on abundances, small flagellated algae, mainly hapto- and prymnesiophytes, were the most abundant groups.

The zooplankton species composition continues to develop according to the trends observed in the 1979–2006 period. The neritic copepod *Pseudocalanus*, which is a very important prey for example for herring, is still declining. This is partly due to decreasing salinity, but is also due to secondary effects of eutrophication, such as deep-water oxygen depletion. The decline of this species affects the whole food web. The invasive American comb jelly *Mnemiopsis leidyi* was not abundant in the Northern Baltic Proper, probably due to hypoxic conditions in the deep waters below the halocline. The individuals recorded were mainly larval stages and they occurred in the upper water layers.

Total oil concentrations in the Northern Baltic Proper have either decreased or stabilised, depending on the area. For example, oil concentrations have decreased significantly on the eastern side of the Gotland deep, while they have stabilised on the western side. FIMR does not monitor contaminants in herring from this area.

Southern Baltic Sea

The southern Baltic Sea did not freeze during the 2006–2007 winter.

In the southern Baltic, and in the Arkona and Bornholm basins, near-bottom oxygen conditions are critical at most sampling stations and at some of these stations no benthic macrofauna at all was recorded.

Chlorophyll-*a* concentrations followed the long-term averages during the growth season and varied between 1–5 mg/m^3.

FIMR does not monitor contaminants in herring from this area.

YHTEENVETO

Yleistä

Keskimääräinen **vedenkorkeus** oli Suomen rannikkoalueilla tammikuussa 2007 poikkeuksellisen korkea, noin 50 cm pitkäaikaisen keskiarvon yläpuolella, korkeimmillaan kuukauden puolivälissä. Suomenlahdella ja Saaristomerellä vedenpinta oli tavanomaista korkeammalla poikkeuksellisen kauan. Muina kuukausina vedenpinta oli 5–25 cm keskimääräistä korkeammalla, paitsi kesäkuussa noin 5 cm alempana ja lokakuussa likimain keskimääräinen.

Aallokkoa mitattiin Suomenlahdella ja varsinaisen Itämeren pohjoisosissa. Näillä alueilla aallokko oli tavanomaista korkeampaa tammi-, huhti-, heinä-, syys- ja joulukuussa. Helmi- ja lokakuussa aallokko oli tavanomaista rauhallisempaa.

Jäätalvi 2006/2007 oli leuto. Ilman lämpötilat olivat joulu- ja maaliskuussa ennätyksellisen korkeat. Ainoastaan helmikuu oli pohjoisessa kylmä. Ensijäätyminen tapahtui marraskuun alussa, mutta laajemmin jäätyminen alkoi vasta tammikuun loppupuolella. Laajimmillaan jää oli helmikuun loppupuolella, jolloin se peitti 33% Itämerestä. Jäätalven kesto Perämeren pohjoisosassa oli keskimääräinen, Perämeren eteläosassa yli kuukauden ja muilla merialueilla puolitoista kuukautta keskimääräistä lyhyempi. Varsinaisella Itämerellä ei esiintynyt lainkaan jäätä.

Itämeren **lämpö-, suola- ja happitilanne** oli yleisesti ottaen keskimääräinen. Suomen rannikkovedet olivat jokseenkin normaalilämpöisiä suurimman osan vuodesta. Tammikuun alussa oli kuitenkin tavanomaista selvästi lämpimämpää ja heinäkuussa esiintyi tavanomaista viileämpi jakso. Pintavedet olivat lämpimimmillään elokuun puolivälissä. Pohjoisen Selkämeren pohjanläheinen happipitoisuus oli suhteellisen alhainen loppukesällä. Suomenlahden vesi sekoittui talvella 2006/2007 laajoilla alueilla pohjaan asti. Suuria suolapulsseja ei tullut Itämereen.

Leväkukinnat: Kevätkukinta Suomenlahdella oli noin viikon etujassa, tavoitti tavanomaisen tason huhtikuun alussa ja päättyi noin kaksi viikkoa tavallista aiemmin. Ensimmäiset sinilevähavainnot tehtiin jo kesäkuun puolivälissä itäisellä Suomenlahdella ja Ahvenanmaan eteläpuolella. Kukinnan muodosti myrkytön *Aphanizomenon*-sinilevä. Kesäkukinta saavutti huippunsa heinäkuun alussa ja oli kaksi kertaa normaalitasoa korkeampi. Kesämaksimin aikaan ainoastaan 1/3 biomassasta muodostui sinilevistä ja 2/3 muista leväryhmistä.

Heinäkuussa säät pysyivät koleina ja tuulisina, joten sinilevää oli vain hajanaisia ja satunnaisia kukintoja Suomenlahdella, Saaristomerellä ja Ahvenanmerellä sekä rannikolla. Sen sijaan elokuun alkupuolella syntyi laajoja pintalauttoja Suomenlahdella, Ahvenanmerellä, Saaristomerellä ja jopa Selkämerellä helteiden ja heinäkuisen kumpuamisen seurauksena. Myös rannikolla esiintyi runsaasti kukintoja. Pintaveden lämmettyä lisääntyi myrkyllisen *Nodu-*

laria spumigena-levän osuus pintaesiintymissä. Tuulet hajoittivat pintalautat, mutta levää oli veteen sekoittuneena elokuun loppuun asti.

Eläinplanktonin seuranta-aineistossa eri merialueilta on nähtävissä selviä muutostrendejä havaintojen alkamisvuodesta 1979 lähtien. Pohjanlahdella eläinplanktonin määrä on runsastunut, eivätkä ravintoverkolle merkittävät lajit ole vähentyneet. Pohjanlahden ekosysteemi ei Suomenlahden tai varsinaisen Itämeren altaan tavoin kärsi hapettomasta syvävedestä, mikä mahdollistaa monille eläinplanktonlajeille tärkeän pääsyn myös syviin vesikerroksiin.Varsinaisella Itämeren altaalla ja Suomenlahdella erityisesti mereinen hankajalkaislaji *Pseudocalanus acuspes* on vähentynyt voimakkaasti. Myös mereiset vesikirppusuvut *Podon* ja *Evadne* ovat vähentyneet. Muut äyriäisplanktonryhmät, kuten hankajalkaiset *Acartia, Temora ja Eurytemora* ovat yleistyneet edellä mainituilla merialueilla.

Uusi **tulokaslaji,** amerikankampamaneetti *Mnemiopsis leidyi*, saapui vuoden 2007 aikana vesialueillemme. Kesän 2007 seurantamatkoilla lajia havaittiin Suomenlahden länsiosassa, Itämeren koilliskulmassa sekä erityisen runsaana Ahvenanmeren ja Selkämeren syvänteissä. Suurimmillaan tiheydet olivat 400–600 yksilöä/m^2 juuri niissä Ahvenanmeren ja Selkämeren syvänteissä, joista myös suurimmat, halkaisijaltaan noin 15mm:n kokoiset yksilöt löytyivät. Lajin havaittiin kykenevän lisääntymään merialueillamme kooltaan pienempänä ja kylmemmässä vedessä kuin aikaisemmin on muualla havaittu. Mitä ilmeisimmin laji on asettunut pysyvästi Itämereen. Viimeisimmät tiedot talven 2007–2008 seurantamatkalta osoittavat, että laji selviää talvesta ja on edelleen runsastunut ja levinnyt laajemmalle.

Meren pintaveden **kokonaisöljypitoisuuksissa** aiempina vuosina havaittu suuntaus jatkuu: pitoisuudet ovat pienentyneet huomattavasti 1990-luvulta vuoteen 2007 yhdeksällä tutkituista kahdestatoista alueesta. Öljypitoisuudet ovat alhaisimpia pohjoisessa, mutta kasvavat etelään mentäessä.

Orgaanisten ympäristömyrkkyjen ja raskasmetallien päästörajoitukset näkyvät selvästi Suomea ympäröivillä merialueilla. DDT- ja PCB-yhdisteiden ja torjunta-aineiden pitoisuudet nuorissa silakoissa ovat vähentyneet merkittävästi. Orgaanisten haitta-aineiden pitoisuudet alittavat ravinnon turvarajat (katso taulukko 1 luvussa 9). Elohopea- ja kadmiumpitoisuudetkin ovat vähentyneet, mutta eivät niin huomattavasti. Elohopean pitoisuudet ovat jopa turvarajoja alhaisempia. Haitallisten ympäristömyrkkyjen yleinen väheneminen on myönteinen merkki Itämeren kuormituksen alenemisesta. Tunnettujen haitallisten ympäristömyrkkyjen väheneminen onkin yksi harvoista Itämerellä tapahtuneista positiivisista muutoksista.

Pohjanlahti

Vedenpinnan korkeuden lyhytaikaisvaihtelu oli tyypilliseen tapaan voimakkainta Perämerellä. Tammikuussa mitattiin Oulussa Suomen rannikon vuoden 2007 suurin vedenkorkeus, +166 cm, ja Raumalla paikallinen ennätyslukema, +123 cm. Toukokuiden paikallisia ennätyskorkeuksia mitattiin Raahessa +57 cm, Pietarsaaressa +54 cm ja Vaasassa +47 cm sekä huhtikuiden paikallinen ennätys Vaasassa +63 cm.

Vaikka ensijäätyminen tapahtui keskimääräiseen aikaan jo marraskuun alkupuolella, alkoi marraskuun loppupuolella leuto jakso, jota kesti aina tammikuun loppupuolelle. Perämeri jäätyi vasta helmikuun alkupuolella noin kolme viikkoa keskimääräistä myöhemmin. Talven aikana Selkämeri ei peittynyt kokonaan jäähän. Selkämeri avautui huhtikuun alkupuolella, noin kaksi viikkoa keskimääräistä aikaisemmin. Perämeri vapautui jäistä keskimääräiseen aikaan toukokuun loppupuolella.

Kesäkuussa pintavesi oli tavallista lämpimämpää, mutta kuun lopulla vedet viilenivät selvästi, ja lämpötila oli paljon tavallista matalampi heinäkuun loppupuolelle asti. Lämpimimmillään pintavedet olivat elokuun keskivaiheilla. Syyskaudella lämpötila oli normaali.

Viime vuosien aikana Selkä- ja Perämerellä syvän veden happitilanne on hiljalleen huonontunut. Happea on pohjan läheisessä vedessä silti pääasiassa riittävästi, joskin pohjoisen Selkämeren lukemat ovat muutamaan otteeseen käyneet jo huolestuttavan alhaalla.

Ravinnepitoisuudet ovat pysyneet Pohjanlahdella melko tasaisina. Selkämerellä sekä nitraatin että fosfaatin pitoisuudet ovat hieman nousseet muutaman viime vuoden aikana.

Pohjanlahden valkokatkayhteisöjen palautumisesta on nähtävissä merkkejä kymmenen vuoden taantumisen jälkeen. Tulokaslaji amerikanmonisukasmadon leviäminen on jatkunut Selkämerellä, joskin niiden tiheydet ovat hieman laskeneet.

Myöhäiskesän planktonleväyhteisöjen koostumus ja biomassa olivat alueelle tyypillisiä. Perämerellä planktonleväyhteisö koostui pääasiassa pienistä siimallisista levistä (suomuviher-, tarttuma- ja kultalevät) sekä yhteyttävästä *Mesodinium rubrum* -ripsieläimestä. Myös Selkämerellä pienet siimalliset levät, pääasiassa kulta- ja tarttumalevät, olivat vallitsevia sekä biomassan että lukumäärän suhteen. Kukintoja muodostavien rihmamaisten sinilevien osuus biomassasta oli vuonna 2007 alhaisempi kuin vuosina 2004–2005.

Eläinplanktonlajiston kehitys jatkuu samanlaisena kuin vuosien 1979–2006 aikasarja osoittaa. Pohjanlahti ei kärsi hapettomasta syvävedestä, joten eläinplanktonlajistossa ei ole suuria muutoksia, ainakaan ravintoverkon kannalta huonompaan suuntaan. Selkämeren syvänteisiin on myös levinnyt tulokaslaji amerikankampamaneetti *Mnemiopsis leidyi*. Sitä tavattiin eteläisen ja pohjoisen Selkämeren syvänteissä melko runsaasti.

Silakoiden DDT- ja PCB-pitoisuudet ovat vähentyneet erittäin merkitsevästi. Torjunta-ainepitoisuudet alittavat havaintorajan. Pintaveden öljypitoisuus on alueella alhainen ja laskusuunnassa, selvimmin Perämerellä. Raskasmetallipitoisuuksissa ei havaittu merkittäviä muutoksia. Perämeren silakoissa havaittiin vuonna 2006 lievä alenema elohopeapitoisuuksissa edellisestä vuodesta. Pohjanlahdella silakan lihaksen ja maksan raskasmetallipitoisuudet ovat yleisesti ottaen alhaisia.

Ahvenanmeri

Pintaveden lämpötilan vuotuinen vaihtelu oli samankaltainen kuin Pohjanlahdella. Syvän veden lämpötila oli suhteellisen korkea ja suolaisuus suunnilleen samalla tasolla kuin parina edellisenä vuotena.

Ahvenanmeri ei jäätynyt talven 2006/2007 aikana.

Ahvenanmeren syvänteet merenalaisen Salpausselän jatkeen pohjoispuolella eivät kärsi hapettomasta pohjavedestä, joten eläinplanktonlajisto on lähes normaali. Mereistä *Pseudocalanus*-, samoin kuin syvän veden *Limnocalanus macrurus* hankajalkaislajia tavataan yleisesti, samoin kuin pohjan läheisessä vesikerroksissa viihtyviä mysidiäyriäisiä. Ahvenanmeren syvänteissä esiintyy myös erittäin runsaana tulokaslaji, amerikankampamaneetti *Mnemiopsis leidyi*.

Haitalliset orgaaniset aineet silakoissa ovat merkittävästi vähentyneet ja raskasmetallipitoisuudet ovat alhaisia. Kokonaisöljyn pitoisuus pintavedessä on ollut selvässä laskussa 1990-luvulta alkaen vuoteen 2007 ulottuvalla jaksolla.

Saaristomeri

Vedenpinta oli tammikuun puolessa välissä poikkeuksellisen korkealla tavanomaista kauemmin. Föglön mareografilla mitattiin tammikuussa paikallinen ennätyskorkeus, +102 cm, talvimyrskyn seurauksena. Matalapaine ja myrskyisä tuuli aiheuttivat heinäkuun lopussa vedenpinnan ajankohtaan nähden tavanomaista kovemman nousun, ja Föglössä mitattiin heinäkuiden paikallinen ennätys, +46 cm.

Saaristomeri peittyi kokonaan jäähän helmikuun puolivälissä, 2–3 viikkoa normaalia myöhemmin. Maaliskuun puolivälissä alue oli jo osittain avoin ja jäljelläoleva jää oli enimmäkseen haurastunutta. Jäät sulivat kokonaan huhtikuun alkupuolella, noin kaksi viikkoa keskimääräistä myöhemmin.

Kesällä vesi oli aluksi tavallista lämpimämpää, mutta heinäkuussa vedet viilenivät. Elokuusta alkaen vesi oli taas koko loppuvuoden ajankohtaan nähden hieman keskimääräistä lämpimämpää.

Veden lämpötila 30–40 metrin syvyydessä oli tavallista korkeampi koko vuoden. Samaan aikaan syvän veden suolaisuus oli paljon tavallista alhaisempi.

Rajavartiolaitoksen lentoseuranta teki ensimmäiset *Aphanizomenon*-sinilevälauttahavainnot jo kesäkuun puolivälissä. Elokuussa tavattiin myös kohtalaisia *Nodularia*-kukintoja.

Alueelta ei ole haitta-aineita koskevaa seurantatietoa.

Suomenlahti

Vedenpinta nousi vuonna 2007 korkeimmilleen tammikuun puolivälissä ja oli korkealla poikkeuksellisen pitkän aikaa. Ennätyskorkeuksia ei kuitenkaan saavutettu. Heinäkuun lopussa vedenpinta kohosi vuodenaikaan nähden tavanomaista korkeammalle, ja Haminassa mitattiin heinäkuiden tähän asti korkein havainto, +104 cm. Lokakuun 12 päivänä vedenpinta laski nopeasti; Haminassa mitattiin vuoden 2007 alhaisin lukema, -80 cm.

Aallokko oli korkeimmillaan tammikuussa, jolloin mitattiin neljän metrin merkitsevä aallonkorkeus. Heinäkuussa aallokko oli tavanomaista korkeampaa, ja kuun lopussa mitattiin vuoden toiseksi korkein aallokko, 3.7 metriä. Tämä oli myös heinäkuiden ennätyslukema. Myös syys- ja joulukuussa aallokko oli jonkin verran tavanomaista korkeampaa. Tammi- ja heinäkuuta lukuunottamatta aallokko pysyi alle kolmen metrin.

Ensijäätyminen tapahtui itäisellä Suomenlahdella joulukuun 2006 loppupuolella noin kolme viikkoa keskimääräistä myöhemmin. Tammikuun alussa vesi oli tavanomaista selvästi lämpimämpää. Varsinaisesti jäätyminen alkoi vasta tammikuun loppupuolella. Helmikuun puolivälissä Suomenlahti oli kokonaan jäässä. Lämpimän sään vuoksi jo maaliskuun puolivälissä Suomenlahti oli taas puoleksi avoin. Jäät sulivat huhtikuun alkupuolella noin kaksi viikkoa normaalia aikaisemmin.

Talvella vedet olivat pohjaan asti sekoittuneet, joten happitilanne oli hyvä myös keskellä Suomenlahtea. Sekoittumisesta johtuen pintaveden ravinnepitoisuudet nousivat verrattain korkeiksi. Keväällä ja alkukesällä vesi oli jokseenkin normaalilämpöistä, mutta heinäkuussa oli tavanomaista viileämpi jakso. Pintavedet olivat lämpimimmillään elokuun puolivälissä ja loppuvuonna lähellä tavanomaisia lämpötiloja.

Kevään aikana Itämeren suurelta altaalta virtasi suolaisempaa ja vähähappisempaa vettä Suomenlahden pohjalle aikaansaaden voimakkaan kerrostumisen ja huonon happitilanteen 70 metriä syvemmillä alueilla. Samalla myös pohjan fosfaattipitoisuus nousi. Myöhemmin kesällä suolaisuus väheni ja happitilanne parani hieman, mutta pysyi huonona. Rikkivetyä havaittiin pohjanläheisessä vedessä taas muutaman vuoden tauon jälkeen Suomenlahden suualueella. Happitilanne muuttui huonoksi Suomenlahden syvillä pohjilla jo vuosikymmen sitten ja johti pohjaeläinyhteisöjen romahtamiseen. Tilanne ei ole parantunut, lukuunottamatta itäisintä näytteenottopistettä. Pohjaeläimet puuttuvat edelleen joko kokonaan tai niiden määrä on hyvin pieni.

Kasviplanktonin kevätkukinta tapahtui normaalia aikaisemmin maaliskuussa. Kesäkukinnan huippu osui heinäkuun alkupuolelle, ja se oli kaksi kertaa voimakkaampi kuin pitkäaikainen keskiarvo. Planktonlevien lukumäärä ja biomassa vedessä elokuussa 2007 oli suurin lähes kymmeneen vuoteen. Ensimmäiset sinilevähavainnot tehtiin jo kesäkuun puolivälissä itäisellä Suomenlahdella. Kesäkuun puolivälin jälkeen tuulet hajottivat pintajuovat ja seuraavat havainnot tehtiin juhannuksen tienoilla läntisellä ja itäisellä Suomenlahdella. Heinäkuussa säät pysyivät koleina ja tuulisina, joten sinilevätilanne ei päässyt kehittymään pahaksi; vain hajanaisia ja satunnaisia kukintoja esiintyi.

Eläinplanktonin lajiston kehitys jatkuu samanlaisena kuin aikasarja vuosilta 1979–2006 osoittaa. Kokonaisbiomassat ovat vähentymässä, erityisesti mereinen hankajalkaislaji *Pseudocalanus*. Tämä johtuu osittain suolaisuuden vähenemisestä, mutta myös rehevöitymisen toissijaisista vaikutuksista kuten syvän veden ajoittaisesta happikadosta.

Haitalliset aineet silakoissa ovat pääosin vähenemässä. Erittäin merkitsevästi ovat vähentyneet DDT- ja PCB-pitoisuudet, jotka alittavat silakan ravintokäyttöä koskevat turva-arvot (katso tarkemmin taulukko 1, luku 9) selvästi. Yleisesti elohopeapitoisuudet Suomenlahdella vaihtelevat suuresti, mutta ovat melko alhaisia ja alle turva-arvojen. Kotkan alueella on silakan pitkän ajan elohopeapitoisuuksissa kuitenkin havaittavissa vähäinen kasvu. Torjunta-ainejäämät ovat niin vähäisiä, että ne alittavat jopa havaintorajan. Kokonaisöljypitoisuudet ovat itäisellä Suomenlahdella olleet huomattavassa laskussa, mutta keskisellä Suomenlahdella ei näy selkeätä suuntausta. Öljypitoisuudet alittavat saastuneen veden turva-arvon.

Pohjoinen varsinainen Itämeri

Merenkäynti tammikuussa oli keskimääräistä kovempaa, ja puolet ajasta merkitsevä aallonkorkeus oli yli kaksi metriä. Tammikuussa mitattiin myös vuoden korkein aallokko, 5.4 metriä. Tammikuun lisäksi huhti-, heinä-, syys- ja joulukuussa aallokko oli tavanomaista korkeampaa, kun taas helmi- ja lokakuu olivat ajankohtiin nähden rauhallisempia. Lokakuussa merkitsevä aallonkorkeus oli 69% ajasta alle metrin.

Meri ei jäätynyt talven 2006/2007 aikana. Pintaveden lämpötilan vaihtelu oli harvojen havaintojen perusteella arvioituna samanlainen kuin muillakin merialueilla, eli vesi oli hieman keskimääräistä lämpimämpää lukuun ottamatta heinäkuun viileää jaksoa. Myös syvät vedet olivat tavallista vähän lämpimämpiä. Pintaveden suolaisuus oli keskimääräistä pienempi ja syvän veden suolaisuus tavallista suurempi, joten kerrostuneisuus oli keskimääräistä voimakkaampaa. Syvässä vedessä näkyy edelleen vuoden 2003 suolapulssin vaikutus.

Rikkivetyä esiintyy syvillä pohjilla, ja pohjaeläimet puuttuvat kokonaan. Ravinnepitoisuuksissa ei ole tapahtunut oleellisia muutoksia.

Kevätkukinnan huippu muodostui huhtikuussa normaalina ajankohtana ja oli hieman pitkäaikaiskeskiarvoja korkeammalla. Sitä seuraava kesähuippu saavutettiin jo heinäkuun alkupuolella kaksi kertaa korkeampana kuin pitkäaikainen keskiarvo. Kukinta muodostui sinilevistä (kolmannes) ja muiden levien epätavallisen korkeasta biomassasta (kaksi kolmannesta).

Planktonlevien biomassa oli vuosittain elokuussa otettavien seurantanäytteiden perusteella vuonna 2007 korkein vuosien 2001–2007 tarkastelujakson aikana. Panssarisiimalevät ja kukintoja muodostavat sinilevät muodostivat yhdessä suurimman osan leväbiomassasta. Lukumäärällä mitaten pienet siimalliset levät, pääasiassa tarttuma- ja suomuviherlevät olivat yleisimpiä.

Eläinplanktonin lajiston kehitys jatkuu samalaisena kuin aikasarja vuosilta 1979–2006 osoittaa. Mereinen hankajalkaislaji *Pseudocalanus*, joka on erittäin tärkeä ravintokohde mm. silakalle, vähenee edelleen. Tämä johtuu osittain suolaisuuden vähenemisestä, mutta myös rehevöitymisen toissijaisista vaikutuksista, kuten syvän veden happikadosta. Lajin vähenemisellä on vaikutuksia koko ravintoverkkoon. Varsinaisen Itämeren altaalla amerikankampamaneettia ei esiintynyt runsaasti, johtuen todennäköisesti suolaisuuden harppauskerroksen alapuolisen syvän veden hapettomuudesta. Tavatut yksilöt olivat lähinnä toukkavaiheita, ja niitä esiintyi ylemmissä vesikerroksissa.

Kokonaisöljypitoisuudet pohjoisella Itämerellä ovat alueesta riippuen joko vähentyneet tai tasaantuneet. Esimerkiksi Gotlannin syvänteen itäpuolella kokonaisöljypitoisuudet ovat erittäin merkittävästi laskeneet ja länsipuolella tasaantuneet. Merentutkimuslaitos ei kerää tältä alueelta silakoita koskevaa seurantatietoa.

Eteläinen Itämeri

Eteläinen varsinainen Itämeri ei jäätynyt talven 2006/2007 aikana.

Eteläisessä Itämerellä sekä Arkonan että Bornholmin altaissa pohjanläheisessä vedessä on happea useimmilla näytteenottopisteillä kriittisen vähän, ja osalla näistä ei tavattu lainkaan pohjaeläimiä.

Klorofylli-*a*-pitoisuudet seurasivat pitkäaikaiskeskiarvoja kasvukauden aikana vaihdellen välillä 1–5 mg/m^3.

Merentutkimuslaitos ei kerää tältä alueelta silakoita koskevaa seurantatietoa.

SAMMANDRAG

Allmänt

I januari 2007 var månadens **medelvattenstånd** i Finska viken ca 50 cm högre än långtidsmedelvärdet vilket är exceptionellt. De högsta värdena mättes i mitten av månaden. Både i Finska viken och i Skärgårdshavet var vattenståndet ovanligt högt under en exceptionellt lång tid. Under de övriga månaderna var vattenståndet 5–25 cm högre än långtidsmedelvärdet, förutom i juni då medelvärdet var ca 5 cm lägre än, och i oktober då värdet var i stort sett detsamma som långtidsmedelvärdet.

Våghöjden mättes i Finska viken och i norra egentliga Östersjön. Våghöjden var högre än normalt under januari, april, juli, september och december. I februari och oktober var sjögången mindre än normalt.

Isvintern 2006–2007 var mild. Under december och mars uppmättes rekordhöga lufttemperaturer. Endast februari var kall i norr. Den första tillfrysningen skedde i början av november, men först i slutet av januari började vattnet frysa till över större områden. Isens största utbredning noterades i slutet av februari, då isen täckte 33% av Östersjön. I den norra delen av Bottenviken var isvinterns längd normal, men i den södra delen över en månad kortare. I de övriga havsområdena var isvintern en och en halv månad kortare än normalt. Egentliga Östersjön var isfri hela vintern.

Temperatur-, salthalts- och syresituationen i Östersjön var allmänt taget normal. I kustvattnen runt Finland var temperaturvärdena någorlunda normala under största delen av året. Början av januari var emellertid klart varmare än normalt och i juli förekom en ovanligt kall period. Ytvattnen var som varmast i medlet av augusti. I den norra delen av Bottenhavet var syrehalten i det bottennära vattnet relativt låg under slutet av sommaren. I stora delar av Finska viken skedde en omblandning av vattnen ända till bottnen under vintern 2006/2007. Inga stora inbrott av saltvatten till Östersjön noterades under året.

Algblomningarna: Vårblomningen i Finska viken började ca en vecka i förtid, nådde sin normala nivå i början av april och tog slut ca två veckor tidigare än normalt. De första observationerna av blågröna alger (cyanobakterier) gjordes redan i mitten av juni i östra Finska viken och söder om Åland. Blomningen bildades av den icke giftiga blågrönalgen *Aphanizomenon*. Sommarblomningen nådde sin kulmen i början av juli och var dubbelt så kraftig som normalt. Sommarmaximets biomassa bestod endast till en tredjedel av blågröna alger, medan två tredjedelar utgjordes av andra alggrupper.

Väderleken var kall och blåsig i juli, vilket ledde till att det förekom endast spridda mindre blomningar av blågröna alger i Finska viken, Skärgårdshavet, Ålands hav och längs kusten. Däremot uppstod det vidsträckta algflottar i början av augusti i Finska viken, Skärgårdshavet, Ålands hav och till och med i Bottenhavet som en följd av det varma vädret och uppvällningen av näringsrikt bottenvatten i juli. Också i kustvattnen förekom det rikligt med blomningar. När ytvattnet blev varmare ökade andelen av den giftiga katthårsalgen (*Nodularia spumigena*) i algflottarna. Vindarna löste upp flottarna, men ända till slutet av augusti förekom det alger i vattnet.

I **djurplanktonsamhällena** kan man observera tydliga förändringar i olika havsområden i det material som insamlats sedan övervakningen inleddes 1979. I Bottniska viken har mängden djurplankton ökat utan att de arter som är betydelsefulla i näringskedjan för den skull minskat. För många djurplanktonarter är djupvattnen av stor vikt. Bottniska viken, i motsats till Finska viken och egentliga Östersjön, lider inte av syrebrist i de bottennära vattnen, vilka sålunda är tillgängliga för djurplanktonet. I egentliga Östersjöns centralbassäng och i Finska viken har framför allt den marina hoppkräftan *Pseudocalanus acuspes* minskat kraftigt. Likaså har de marina vattenlopporna *Podon* och *Evadne* minskat. Andra grupper av planktiska kräftdjur såsom *Acartia*, *Temora* och *Eurytemora* har blivit vanligare i de ovan nämnda områdena.

En ny **invandrarart**, den amerikanska kammaneten *Mnemiopsis leidyi*, anlände under år 2007 till våra vatten. Under sommarens expeditioner för uppföljning av Östersjöns tillstånd observerades arten i västra Finska viken, i den nordöstra delen av egentliga Östersjön, och speciellt rikligt i djupbassängerna i Ålands hav och Bottenhavet, där man också hittade de största individerna med en diameter på ca 15 mm. I djupbassängerna observerades också de största individtätheterna, 400–600 individer/m^2. Man kunde konstatera att arten i våra vattenområden är kapabel att föröka sig i kallare vatten och vid mindre storlek än vad som tidigare observerats i andra hav. Med största sannolikhet har arten etablerat sig för gott i Östersjön. De nyaste uppgifterna från uppföljningsexpeditionerna vintern 2007/2008 visar att arten klarar av vintern och har fortsatt att öka i antal och erövra nya områden.

Den trend som observerats i **totalhalterna av olja** i ytvattnen under de senaste åren har fortsatt. Halterna har minskat påtagligt från 1990-talet till 2007 på nio av de tolv undersökta områdena. Oljehalterna är lägst i norr och ökar när man går söderut.

Utsläppsregleringarna av **organiska miljögifter och tungmetaller** syns tydligt i de vattenområden som omger Finland. DDT- och PCB-föreningarna samt halterna av bekämpningsmedel i unga strömmingar har minskat märkbart. Halterna av skadliga organiska ämnen underskrider gränsvärdena för livsmedel (se Kapitel 9, Tabell 1). Kvicksilver- och kadmiumhalterna har också minskat, men inte lika påtagligt. Kvicksilverhalterna är till och med lägre än gränsvärdena. Den allmänna minskningen av miljögifter är ett positivt tecken på att belastningen på Östersjön minskat. Minskningen av kända, skadliga miljögifter är en av de få positiva förändringarna i Östersjön.

Bottniska viken

Korttidsvariationen i vattenståndet var, som normalt, störst i Bottenviken. Det högsta vattenståndet vid Finlands kuster år 2007, +166 cm, uppmättes i Uleåborg i januari, då också det lokala rekordvärdet för Raumo, +123 cm, uppmättes. Lokala rekordvärden för maj månad uppmättes i Brahestad (+57 cm), Jakobstad (+54 cm) och Vasa (+47 cm). I Vasa uppmättes även det lokala rekordvärdet för april (+63 cm).

Den första isen lade sig vid normal tidpunkt, redan i början av november. I slutet av månaden började emellertid en mild period som varade ända till slutet av januari. Bottenviken frös till först i början av februari, vilket är ca tre veckor senare än normalt. Bottenhavet frös inte helt till på hela vintern. I Bottenhavet gick isen i början av april, ca två veckor tidigare än normalt. I Bottenviken gick isen vid normal tidpunkt, i slutet av maj.

I juni var vattnet varmare än normalt, men i slutet av månaden svalnade det betydligt varefter det var mycket kallare än normalt ända till slutet av juli. Ytvattnen var som varmast i medlet av augusti. Under hösten var temperaturerna normala.

Under de senaste åren har syresituationen i djupvattnen i Bottenhavet och Bottenviken långsamt blivit sämre. Huvudsakligen finns det ändå tillräckligt syre i vattnet även om syrevärdena i den norra delen av Bottenhavet några gånger varit alarmerande låga.

Närsaltshalterna i Bottniska viken har varit tämligen stabila. I Bottenhavet har både nitrat- och fosfathalterna stigit en aning under de senaste åren.

Vitmärlesamhällena i Bottniska viken visar tecken på att återhämta sig efter en tio års tillbakagång. Den amerikanska havsborstmasken har fortsatt att breda ut sig i Bottenhavet även om individantalet minskat något.

Under sensommaren var växtplanktonsamhällenas artsammansättning och biomassa typiska för årstiden. I Bottenviken bestod algsamhällena huvudsakligen av små, gisselförsedda alger (fjällgrön-, häft- och guldalger) samt av *Mesodinium rubrum*, en assimilerande ciliat. Också i Bottenhavet dominerade små gisselförsedda alger, huvudsakligen guld- och häftalger, både i fråga om biomassa och antal. De trådformiga blågröna algernas andel av algblomningarnas biomassa var år 2007 mindre än under åren 2004–2005.

När det gäller djurplanktonsamhällenas artsammansättning fortsätter den trend som observerats i tidsserien för 1979–2006. Bottniska viken lider inte av syrebrist, följaktligen har det inte skett några förändringar i artsammansättningen till det sämre för näringskedjan. Årets nykomling, den amerikanska kammaneten *Mnemiopsis leidyi*, har spritt sig också till Bottenhavet, där den påträffats i relativt stora mängder i djupområdena både i söder och norr.

DDT- och PCB-halterna i strömming har minskat drastiskt. Halterna av bekämpningsmedel underskrider detektionsgränserna. Halten olja i ytvattnet är låg och sjunker ytterligare i området, speciellt i Bottenviken. När det gäller halterna av tungmetaller har inga märkbara förändringar observerats. En liten nedgång i kvicksilverhalten i strömming jämfört med föregående år observerades i Bottenviken. Halterna av tungmetaller i strömmingens muskelvävnad och lever är allmänt taget låga i Bottniska viken.

Ålands hav

Variationen i ytvattentemperaturerna under året var i stort sett densamma som i Bottniska viken. Temperaturen i djupvattnen var förhållandevis hög och salthalten ungefär densamma som under de två senaste åren.

Ålands hav var isfritt hela vintern 2006/2007.

Den del av Ålands hav som är belägen norr om Stängselåsens förlängning lider inte av syrebrist i det bottennära vattnet och därför är djurplanktonartsammansättningen i det närmaste normal. Den marina hoppkräftan *Pseudocalanus* och den i djupvatten förekommande hoppkräftan *Limnocalanus macrurus* påträffas allmänt, likaså mysider som lever i bottennära vatten. I djupbassängerna i Ålands hav påträffas även stora mängder av den nya amerikanska kammaneten *Mnemiopsis leidyi*.

De skadliga organiska ämnena i strömming har minskat märkbart och tungmetallhalterna är låga. Totalhalterna av olja i ytvattnen har visat en klart sjunkande trend från 1990-talet till 2007.

Skärgårdshavet

Vattenståndet var i medlet av januari exceptionellt högt under en lång period. I januari uppmättes vid mareografen i Föglö ett nytt lokalt rekordvärde (+102 cm) i samband med en vinterstorm. Lågtryck och stormvindar ledde i slutet av juli till att vattenståndet steg för årstiden ovanligt kraftigt och ett lokalt rekordvärde för juli månad uppmättes i Föglö (+46 cm).

Skärgårdshavet frös till helt i medlet av februari, 2–3 veckor senare än normalt. I medlet av mars var området redan delvis öppet och den kvarvarande isen var rutten. Isarna smalt helt i början av april, ca två veckor senare än normalt.

Under sommaren var vattnet först varmare än vanligt, men i juli blev det svalare. Från och med augusti till årets slut var vattnet sedan aningen varmare än långtidsmedelvärdet. Vattnets temperatur på 30–40 meters djup var högre än vanligt under hela året. Samtidigt var djupvattnets salthalt betydligt lägre än normalt.

Redan i medlet av juni observerades under gränsbevakningens övervakningsflygningar de första blomningarna av blågrönalgen *Aphanizomenon*. I augusti påträffades även måttliga blomningar av *Nodularia*.

Havsforskningsinstitutet insamlar inte information om miljögifter i Skärgårdshavet.

Finska viken

Under år 2007 var vattenståndet som högst i medlet av januari och förblev högt under en exceptionellt lång tid. Några nya rekord noterades ändå inte då. I slutet av juli steg vattenståndet för årstiden ovanligt högt och i Fredrikshamn uppmättes det hittills högsta vattenståndet för juli månad (+104 cm). Den 12. oktober sjönk vattenståndet snabbt och i Fredrikshamn uppmättes årets lägsta vattenstånd (-80 cm).

Sjögången var som högst i januari, då en signifikant våghöjd på fyra meter uppmättes. I juli var sjögången högre än normalt och i slutet av månaden uppmättes årets nästhögsta vågor, 3.7 meter, vilket även var ett nytt rekord för juli månad. Även i september och december var sjögången något kraftigare än normalt. Med undantag för januari och juli var sjögången under tre meter.

Den första tillfrysningen skedde i östra Finska viken mot slutet av december 2006, ca tre veckor senare än normalt. I början av januari var vattnet betydligt varmare än normalt och den egentliga tillfrysningen började först mot slutet av månaden. I medlet av februari var hela Finska viken istäckt. På grund av det varma vädret var halva Finska viken igen isfri redan i medlet av mars. Isarna smalt helt i början av april, ca två veckor tidigare än normalt.

Under vintern hade vattnen omblandats ända till bottnen och syresituationen var således god även i de centrala delarna av Finska viken. På grund av omblandningen var ytvattnets närsaltshalter relativt höga. Under våren och försommaren var vattentemperaturen tämligen normal, men i juli inföll en svalare period. Ytvattnen var som varmast i medlet av augusti och följde sedan normala värden under resten av året.

Under våren strömmade saltare och syrefattigare vatten från egentliga Östersjön in längs Finska vikens botten och förorsakade en kraftig skiktning av vattnet och dåliga syreförhållanden på större än 70 meters djup. Samtidigt steg också fosfathalterna i bottenvattnet. Senare under sommaren sjönk salthalten och syresituationen förbättrades något, men den förblev ändå dålig. Svavelväte påträffades igen i bottenvattnen vid Finska vikens mynning, något man inte påträffat under några års tid. Syresituationen i Finska vikens djupområden försvagades redan för ett tiotal år sedan och bottenfaunasamhällena kollapsade. Med undantag för den östligaste provtagningsstationen, har situationen inte förbättrats; bottendjur saknas fortfarande fullständigt eller påträffas bara i små mängder.

Vårblomningen av växtplankton skedde tidigare än normalt i mars. Sommarblomningen nådde sin kulmen i början av juli och var dubbelt så kraftig som långtidsmedelvärdet. Planktonalgernas abundans och biomassa i augusti 2007 var den högsta på närmare tio år. De första observationerna av blågröna alger gjordes redan i medlet av juni i östra Finska viken, men därefter löste vindarna upp ytansamlingarna. De följande observationerna av blomningar gjordes kring midsommar i västra och östra Finska viken. I juli var väderleken kall och blåsig, vilket förhindrade större blomningar från att uppstå och endast spridda mindre blomningar förekom.

När det gäller djurplanktonsamhällenas artsammansättning fortsätter den trend som observerats i tidsserien för 1979–2006. Totalbiomassorna har minskat, speciellt i avseende av den marina hoppkräftan *Pseudocalanus*. Det här beror delvis på att salthalten minskat, men även på sekundära effekter av övergödningen, så som återkommande syrebrist i djupvattnen.

Halterna av skadliga ämnen i strömming håller generellt på att sjunka. I synnerhet har DDT- och PCB-halterna minskat märkbart och underskrider klart gränsvärdena för livsmedel (se Kapitel 8, Tabell 1). Kvicksilverhalterna varierar överlag kraftigt i Finska viken, men är tämligen låga och under gränsvärdena. Utanför Kotka har dock en liten ökning av kvicksilverhalten i strömming observerats. Halterna av bekämpningsmedel är så låga att de underskrider detektionsgränserna. Totalhalterna av olja har sjunkit märkbart i östra Finska viken, men i de centrala delarna av Finska viken syns ingen klar trend. Oljehalterna ligger under gränsvärdet för förorenat vatten.

Norra egentliga Östersjön

Sjögången var kraftigare än normalt i januari och den signifikanta våghöjden var över två meter under hälften av tiden. I januari uppmättes även årets högsta sjögång, 5.4 meter. Även i april, juli, september och december var sjögången kraftigare än normalt, medan februari och oktober var lugnare än normalt. I oktober var den signifikanta våghöjden under en meter under 49% av tiden. Havet var isfritt hela vintern 2006/2007. Baserat på de få tillgängliga observationerna, följde ytvattentemperaturerna samma mönster som observerades i övriga havsområden; vattnet var något varmare än normalt, förutom under en svalare period i juli. Även djupvattnen var något varmare än normalt. Ytvattnets salthalt var lägre än i medeltal, medan djupvattnets salthalt var högre. Därför var vattenmassans skiktning kraftigare än normalt. Inflödet av saltvatten år 2003 kan ännu skönjas i djupvattnet.

Svavelväte förekommer på de djupa bottnarna och bottenfauna saknas helt. Närsaltshalterna har inte förändrats nämnvärt.

Vårblomningen nådde sin kulmen vid den normala tidpunkten i april och var något kraftigare än långtidsmedelvärdet. Sommarblomningen nådde sin kulmen redan i början av juli och var dubbelt så kraftig som normalt. Sommarmaximets biomassa bestod endast till en tredjedel av blågröna alger, medan två tredjedelar utgjordes av andra alggruppers ovanligt höga biomassa.

På basen av den övervakning som görs årligen i augusti, var planktonalgernas biomassa år 2007 den högsta under perioden 2001–2007. Pansarflagellater och blomningsbildande blågröna alger utgjorde tillsammans den största delen av biomassan. Till antalet var de små gisselförsedda algerna, främst häft- och fjällgrönalger, allmännast.

När det gäller djurplanktonsamhällenas artsammansättning fortsätter den trend som observerats i tidsserien för 1979–2006. Den marina hoppkräftan *Pseudocalanus*, som är en mycket viktig födokälla för bland annat strömmingen, har fortsatt att minska. Det här beror delvis på att salthalten minskat, men även på sekundära effekter av övergödningen, så som återkommande syrebrist i djupvattnen. Artens tillbakagång påverkar hela näringsväven. I egentliga Östersjön förkom den amerikanska kammaneten inte i större mängder, antagligen på grund av dåliga syreförhållanden i djupvattnen under salthaltssprångskiktet. De individer som påträffades var främst larvstadier och de förekom i de övre vattenlagren.

I norra egentliga Östersjön har totalhalterna av olja antingen minskat eller stabiliserats, beroende av område. Till exempel öster om Gotlandsdjupet har oljehalterna sjunkit synnerligen kraftigt, medan de väster om Gotlandsdjupet har stabiliserats. Havsforskningsinstitutet insamlar inte information om skadliga ämnen i strömming från det här området.

Södra Östersjön

Södra Östersjön frös inte till under vintern 2006/2007.

I södra Östersjön, samt i Arkona- och Bornholmsbassängen, var syrenivåerna i det bottennära vattnet kritiskt låga på de flesta provtagningsstationerna och på en del av stationerna påträffades ingen bottenfauna alls.

Halterna av klorofyll-*a* följde långtidsmedelvärdena under tillväxtperioden och varierade mellan 1–5 mg/m^3.

Havsforskningsinstitutet insamlar inte information om skadliga ämnen i strömming från det här området.

1. SEA LEVEL VARIATION ON THE FINNISH COAST

Hanna Boman

Introduction

In January 2007 the average sea level on the Finnish coast was exceptionally high, about 50 cm higher than the long-term average. In December 2006 it had already been at its highest for 2006, +50 – +60 cm, but after the turn of the year it rose still further to its highest value for 2007, about +70 cm, in the middle of January. In the Gulf of Finland and in the Archipelago Sea the average sea level was uncommonly high for an exceptionally long time. During the other months of 2007 the average sea level was 5–25 cm higher than the long-term average except for June, when it was about 5 cm lower and October, when it was near the average. Fig. 1 shows the monthly means of the sea level in 2007 for Föglö compared to the long-term averages of monthly mean (similar Bildes for all stations in Annex 1).

In 2007 the short-term fluctuation was strongest in January, and two local annual records were measured: +102 cm at Föglö, and +123 cm at Rauma. Locally, the strongest fluctuation occurred typically in the Bay of Bothnia, where the highest 2007 value, +166 cm, was measured at Oulu on Jan 16th. A local record for April, +63 cm, was measured at Vaasa , as well as local records for May at Raahe, +57 cm, at pietarsaari, +54 cm, and at Vaasa, +47 cm. At the end of July a low pressure system and stormy winds raised the sea level higher than normally in summer in the Gulf of Finland and in the Archipelago Sea, and on the 31st July a record for July on the Finnish coast, +104 cm, was measured at Hamina, and also the local record for July, at Föglö +46 cm. On the 12th October a rapid fall occurred in the Gulf of Finland, the lowest measurement at Hamina being -80 cm. Fig. 2 shows the 2007 monthly extreme values for Föglö, with the earlier observed maxima and the minima up to the end of 2006 for comparison (similar Bildes for all stations in Annex 2). The daily mean and the total daily variation of sea level in 2007 for Hamina are seen in Fig. 3 (similar Bildes for all stations in Annex 3).

The theoretical mean sea level

The theoretical mean sea level is a forecast, made for practical purposes, of the long-term mean value of sea level. More precisely, it is an expectation value calculated such that the land uplift as well as the slow rise in sea level are taken into account. Because of these changes the theoretical mean sea level is not a constant. The FIMR monitors the change yearly, and confirms the height of the theoretical mean sea level for 5 years onwards. The theoretical mean sea level is commonly used in Finland as a reference level when sea level information is given to the public, for instance on the internet or radio and in the newspapers.

Teoreettinen keskivesi

Teoreettinen keskivesi on käytännön tarpeita varten tehty ennuste vedenkorkeuden pitkäaikaisesta keskiarvosta. Tarkemmin ilmaistuna se on odotusarvo, jossa on otettu huomioon maan kohoaminen sekä vedenkorkeuden hidas nousu. Näiden muutosten vuoksi teoreettinen keskivesi ei ole vakio. Merentutkimuslaitos tarkkailee muutosta vuosittain ja vahvistaa teoreettisen keskiveden korkeuden viideksi vuodeksi. Teoreettista keskivettä käytetään Suomessa ilmoitettaessa vedenkorkeustietoja yleisölle, esimerkiksi internetissä, radiossa ja sanomalehdissä.

Teoretiska medelvattnet

Det teoretiska medelvattnet är en prognos som gjorts för praktiska ändamål av det långvariga vattenståndets medelvärden. Mera exakt uttryckt är det ett väntevärde där man har tagit i beaktande landhöjningen samt att vattenståndets långsamt stiger. På grund av dessa förändringar är det teoretiska medelvattnet inte konstant. Havsforskningsinstitutet iakttar den årliga förändringen och bekräftar höjden av det teoretiska medelvattnet för fem år i taget. I Finland används det teoretiska medelvattnet som referens då information om vattenståndet ges åt allmänheten via t.ex. internet, radio och dagstidningar.

The regional distribution of annual frequencies is depicted in Fig. 4, and the annual distributions of monthly frequencies at Oulu, Mäntyluoto, Föglö and Helsinki are seen in Fig. 5, based on the full time series up to the end of 2006, together with the corresponding distributions for 2007.

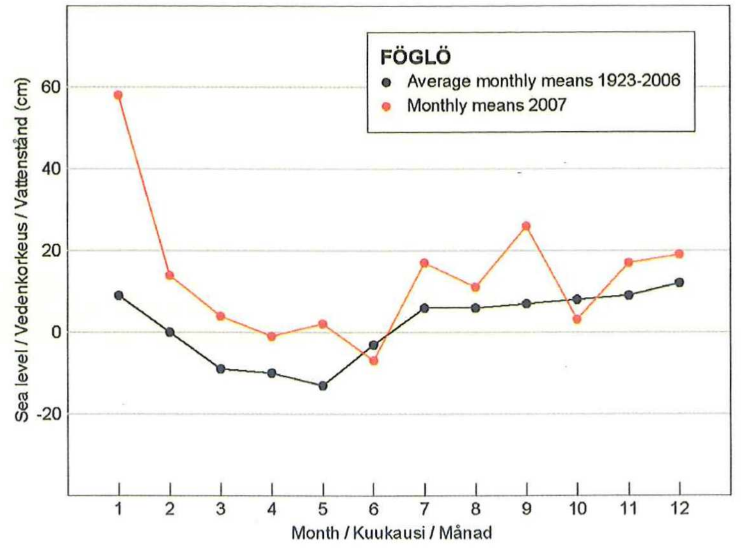


Fig. 1. The monthly means of the 2007 sea level heights compared to the average monthly means of all observations up to the end of 2006 for Föglö, referred to the theoretical mean sea level (cm).

Kuva 1. Föglön vedenkorkeuden kuukausikeskiarvot vuonna 2007 verrattuna keskimääräisiin kuukausikeskiarvoihin koko havaintojaksolta vuoden 2006 loppuun teoreettisen keskiveden suhteen (cm).

Bild 1. Vattenståndets månadsmedelvärden i Föglö år 2007 jämfört med hela observationsperiodens genomsnittliga månadsmedelvärden till slutet av år 2006 i förhållande till det teoretiska medelvattnet (cm).

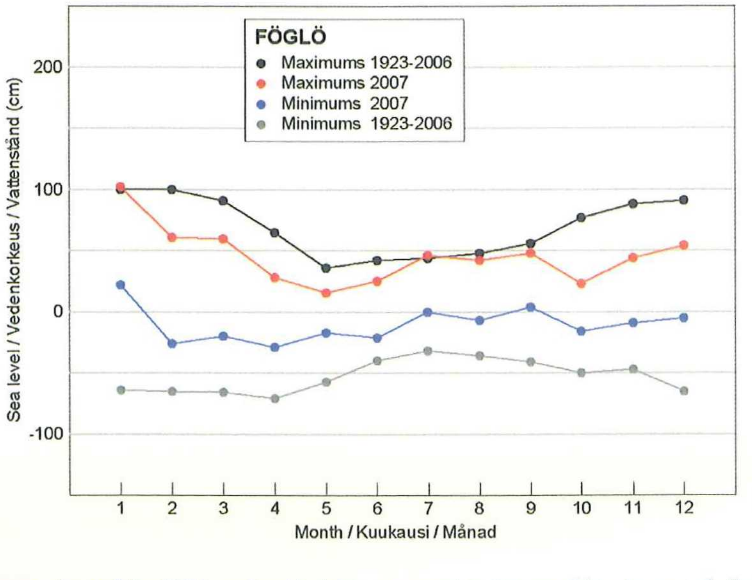


Fig. 2. The monthly extreme values of the 2007 sea level heights compared to the monthly extremes of all observations until the end of 2006 for Föglö, referred to the theoretical mean sea level (cm).

Kuva 2. Föglön vedenkorkeuden kuukausiääriarvot vuonna 2007 verrattuna koko havaintojakson kuukausiääriarvoihin vuoden 2006 loppuun teoreettisen keskiveden suhteen (cm).

Bild 2. Vattenståndets månadsextremvärden i Föglö år 2007 jämfört med hela observationsperiodens månadsextremvärden till slutet av år 2006 i förhållande till det teoretiska medelvattnet (cm).

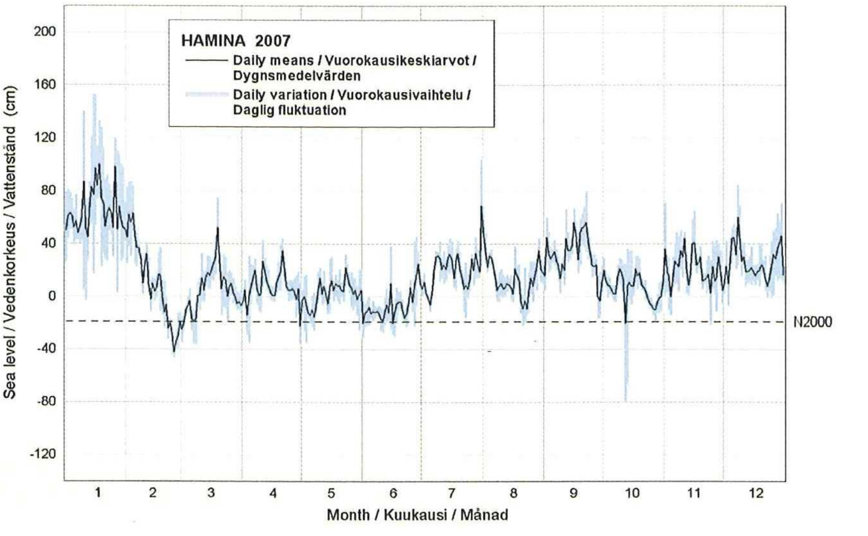


Fig. 3. The daily means (black) and the total daily variation (blue) of the 2007 sea level heights for Hamina referred to the theoretical mean sea level 2007. The height of the new Finnish national reference level N2000 is also shown (dashed line).

Kuva 3. Vedenkorkeuden vuorokausikeskiarvot (musta) ja vuorokauden kokonaisvaihtelu (sininen) vuonna 2007 sekä Suomen uuden kansallisen korkeusjärjestelmän N2000 korkeus (katkoviiva) Haminassa vuoden 2007 teoreettisen keskiveden suhteen.

Bild 3. Vattenståndets dygnsmedelvärden (svart linje) och totala dagliga fluktuation (blått fält) år 2007 i förhållande till det teoretiska medelvattnet 2007 i Fredrikshamn. Den streckade linjen indikerar höjden på Finlands nya referensnivå, N2000.

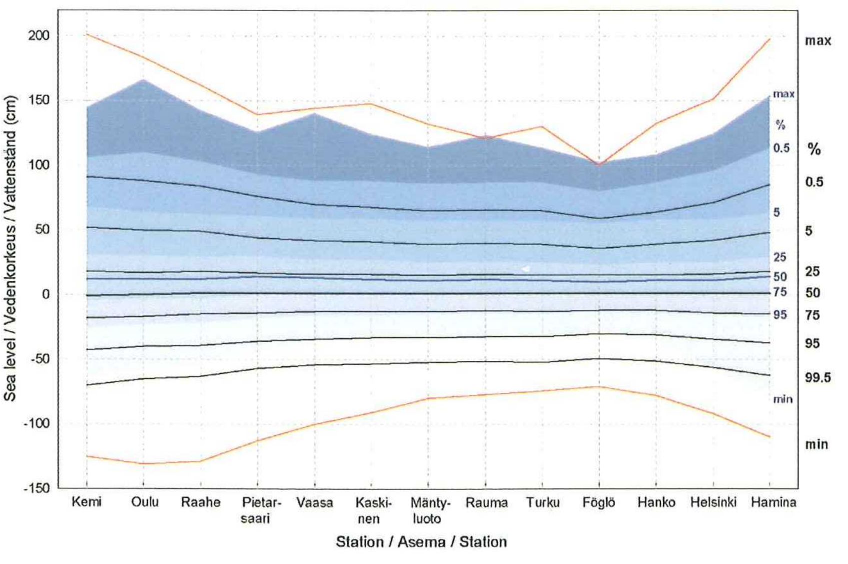


Fig. 4. The regional distribution of the annual frequencies of sea level heights (black curves) and the extremes (red curves), based on the whole time series up to the end of 2006, together with the 2007 distribution (blue areas and blue curve of 50%), referred to the theoretical mean sea level (cm). The percentages represent the time that the sea level reaches or exceeds the value of the curve during a year, for example 5% corresponds to 18 days in a year.

Kuva 4. Vedenkorkeuden vuosifrekvenssien alueellinen jakauma (mustat käyrät) ja ääriarvot (punaiset käyrät) koko havaintoaineistosta vuoden 2006 loppuun sekä vuoden 2007 vastaava jakauma (siniset alueet ja sininen 50% käyrä) teoreettisen keskiveden suhteen (cm). Prosenttiluvut kuvaavat sitä aikaa vuodesta, jonka vedenkorkeus on suurempi tai yhtä suuri kuin käyrän vedenkorkeus, esim. 5% vastaa 18 päivää vuodessa.

Bild 4. Fördelning av vattenståndets regionala årsfrekvenser (de svarta kurvorna) och extremvärden (röda kurvorna) för hela observationsmaterialet till slutet av år 2006 samt motsvarande fördelning år 2007 (de blåa områdena och den blåa 50 %-kurvan) i förhållandet till det teoretiska medelvattnet (cm). Procenttalen betecknar den tid av året då vattenståndet är större eller lika stor som värdet på kurvan, t.ex. 5% motsvarar 18 dagar i året.

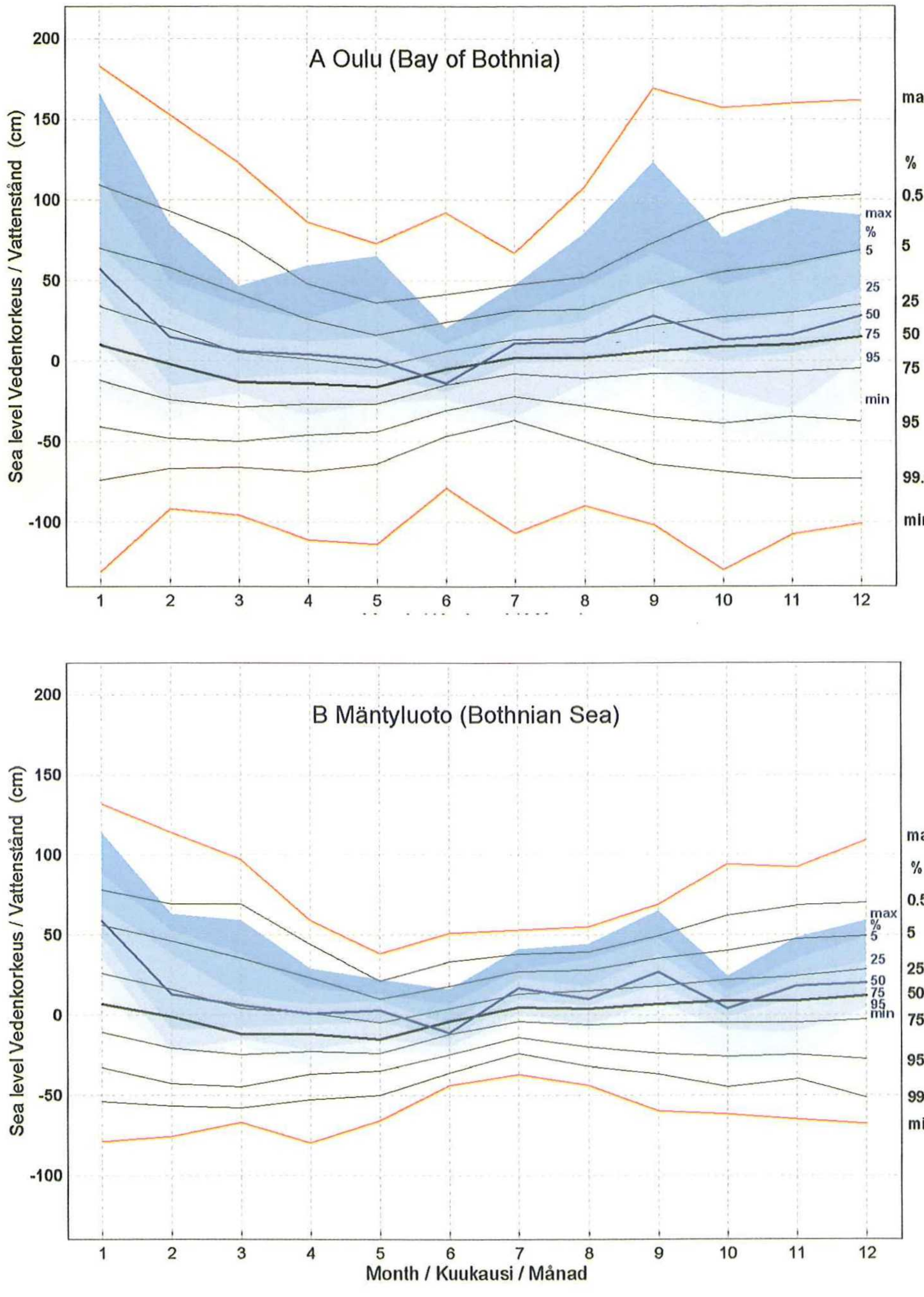
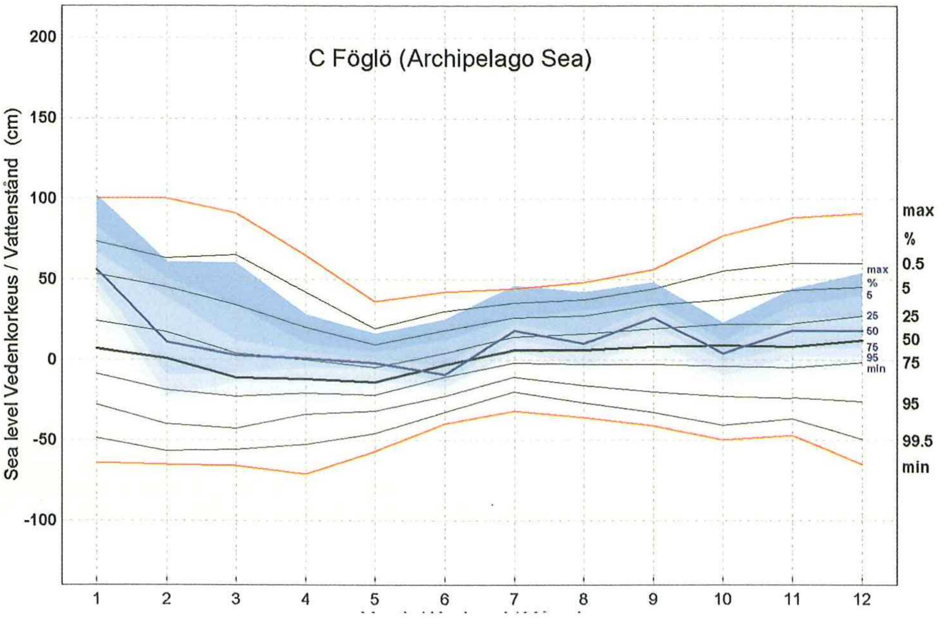
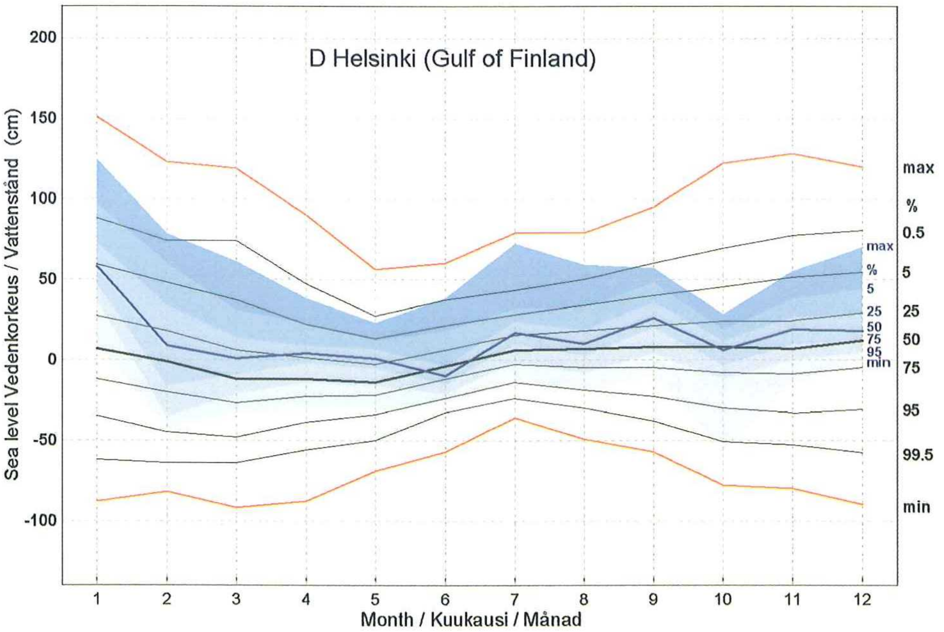


Fig. 5 (A–D). The annual distribution of the monthly frequencies of sea level heights (black curves) and the extremes (red curves) based on the whole time series up to the end of 2006 together with the 2007 distribution (blue areas and blue curve of 50%), referred to the theoretical mean sea level (cm), for A) Oulu, B) Mäntyluoto, C) Föglö and D) Helsinki. The percentages represent the time that the sea level reaches or exceeds the value of the curve during a month, for example 50% corresponds to 15 days in a month.

Kuva 5 (A–D). Vedenkorkeuden kuukausifrekvenssien vuotuinen jakauma (mustat käyrät) ja ääriarvot (punaiset käyrät) koko havaintoaineistosta vuoden 2006 loppuun sekä vuoden 2007 vastaava jakauma (siniset alueet ja sininen 50% käyrä) teoreettisen keskiveden suhteen (cm), A) Oulussa, B) Mäntyluodossa, C) Föglössä ja D) Helsingissä. Prosenttiluvut kuvaavat sitä aikaa kuukaudesta, jonka vedenkorkeus on suurempi tai yhtä suuri kuin käyrän vedenkorkeus, esim. 50% vastaa 15 päivää kuukaudessa.

Bild 5 (A–D). Vattenståndets årliga fördelning av månadsfrekvenserna (de svarta kurvorna) och extremvärdena (de röda kurvorna) för hela observationsmaterialet till slutet av år 2006 samt motsvarande fördelning år 2007 (de blåa områden och den blåa 50 %-kurvan) i förhållandet till det teoretiska medelvattnet (cm), för A) Uleåborg, B) Mäntyluoto, C) Föglö och D) Helsingfors. Procenttalen betecknar den tid av månaden då vattenståndet är större eller lika stort som värdet på kurvan, t.ex. 50% motsvarar 15 dagar i månaden.


C Föglö (Archipelago Sea)
Sea level Vedenkorkeus / Vattenstånd (cm)
200
150
100
50
0
-50
-100
1 2 3 4 5 6 7 8 9 10 11 12
max
%
0.5
5
25
50
75
95
99.5
min


D Helsinki (Gulf of Finland)
Sea level Vedenkorkeus / Vattenstånd (cm)
200
150
100
50
0
-50
-100
1 2 3 4 5 6 7 8 9 10 11 12
Month / Kuukausi / Månad
max
%
0.5
5
25
50
75
95
99.5
min

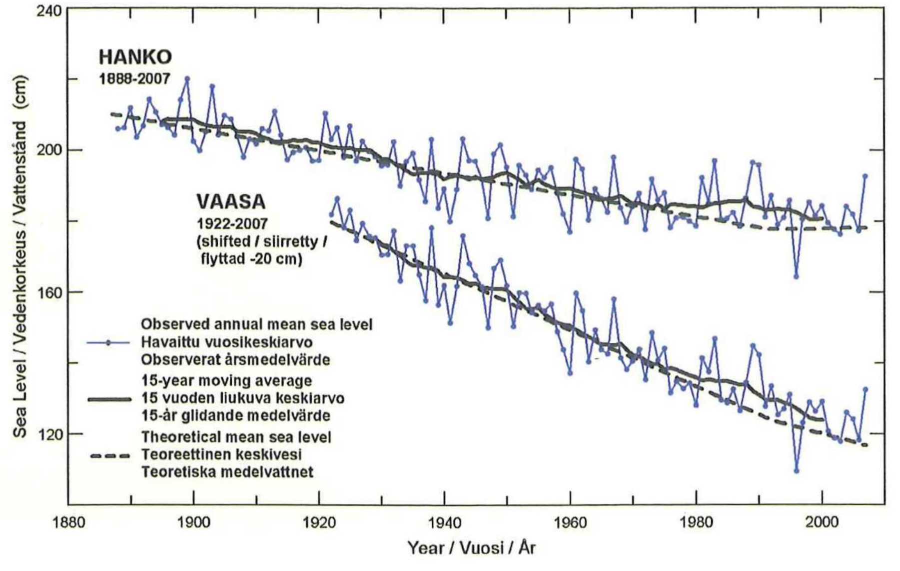


Fig. 6. The observed annual means for Hanko and Vaasa (blue), together with the 15-year moving average (black solid), referred to the FIMR standard bedrock-bound reference level, and the theoretical mean sea level (dashed).

Kuva 6. Vedenkorkeuden havaitut vuosikeskiarvot (sininen) Hangossa ja Vaasassa 15-vuoden liukuvine keskiarvoineen (musta yhtenäinen) Merentutkimuslaitoksen määrittämän kiinteän kallioon sidotun referenssitason suhteen, sekä teoreettinen keskivesi (katkoviiva).

Bild 6. Vattenståndets observerade årsmedelvärden (blå linje) och 15-års glidande medelvärden (den svarta heldragna linjen) för Hangö och Vasa i förhållande till den av Havsforskningsinstitutet fastställda stabila bergsbundna referensnivån, samt det teoretiska medelvattnet (den streckade linje).

The trends of the annual means of sea level at Hanko and Vaasa are presented in Fig. 6, together with the theoretical mean sea level. The yearly change of the mean sea level is considerably faster at Vaasa than at Hanko because of the stronger land uplift rate. More about the mean sea level on the Finnish coast may be found in Johansson & al. (2003) and Johansson & al. (2004).

The new Finnish national height system N2000 was released in 2007. In this report the sea level values are referenced to the same theoretical mean sea level as in the preceding report for 2006. The N2000 level is given in the Bildes of daily variation (Fig. 3 and Annex 3) referred to the theoretical mean sea level of 2007, and in Table 1 referred to the earlier Finnish national height system N60 and the theoretical mean sea level of 2007.

Finnish national height system N2000

The N2000 height system is based on the Third Levelling of Finland (1978–2006). It is a Finnish realisation of the common European height system, and its datum is derived from NAP (Normaal Amsterdam Peil). The heights of N2000 differ 13–43 cm from the heights of the previous Finnish national height system N60. Most of the difference is due to the land uplift during 40 years: the N2000 heights are based on the values of the vertical motion in 2000, and those of N60 on those in 1960. There are also differences in computation. (Saaranen & al. 2006, JHS 163 2007, Poutanen 2006).

Suomen kansallinen korkeusjärjestemä N2000

Korkeusjärjestelmä N2000 perustuu Suomen kolmanteen tarkkavaaitukseen (1978–2006). Se on yhteisen eurooppalaisen korkeusjärjestelmän suomalainen realisaatio, lähtötasonaan NAP (Normaal Amsterdams Peil). N2000-järjestelmän korkeudet poikkeavat 13–43 cm Suomen aiemmasta valtakunnallisesta korkeusjärjestelmästä N60. Suurin osa erosta johtuu 40 vuoden aikana tapahtuneesta maannoususta: N2000-korkeudet on laskettu vuoden 2000 maannousun mukaisina, N60-korkeudet vuoden 1960 mukaisina. Järjestelmien laskennassa on myös eroa. (Saaranen & al. 2006, JHS 163 2007, Poutanen 2006).

Finlands nationella höjdsystem N2000

Höjdsystemet N2000 bygger på Finlands tredje precisionsavvägning (1978–2006). Det är en finländsk realisering av det alleuropeiska höjdsystemet och dess utgångsnivå definieras av NAP (Normaal Amsterdams Peil). N2000-höjd värdena avviker 13–43 cm från höjd angivelserna i Finlands tidigare nationella höjdsystem N60. Skillnaden beror främst på den landhöjning som skett under de senaste 40 åren: N2000-höjdvärdena bygger på landhöjningssituationen år 2000 och N60 på situationen år 1960. Det förekommer också olikheter i uträkningarna. (Saaranen & al. 2006, JHS 163 2007, Poutanen 2006).

January

The weather was rainy and stormy at times. On 14th–15th a strong winter storm, moving over the southwestern sea area, raised the water level exceptionally high, the highest in 2007, and two local annual records were measured: on Jan 14th in the Archipelago Sea, at Föglö, +102 cm, and on Jan 16th in the southern Gulf of Bothnia, at Rauma, +123 cm. On 25th–26th stormy winds caused another rise in the Bay of Bothnia. The monthly mean was 47–56 cm higher than the long-term average, and one of the three to five highest ever measured on the Finnish coast. In the Gulf of Finland and in the Archipelago Sea, the uncommonly high water level continued for an exceptionally long time.

February

During February high pressure dominated, and by the end of the month the sea level fell to a level of about -20 cm. The monthly mean still remained 10–16 cm above the long-term average.

March

The water level rose again, and an extensive low pressure system after the middle of the month caused a temporarily rise; +75 cm was measured at Turku and at Hamina, but no record levels. Thereafter the water level started to fall again. The monthly mean was 12–16 cm above the long-term average.

April

The sea level fluctuated mainly around the zero level. On 11th April a low pressure area moving from the Norwegian Sea to the east caused a temporary rise in the northern Gulf of Bothnia, and a local record for April, +63 cm, was measured at Vaasa. The monthly mean was 9–18 cm above the long-term average.

May

In the first half of the month the sea level rose. After the middle of the month a deep low pressure centre moved from the Norwegian Sea to the Arctic Ocean, causing a temporarily rise in the Bay of Bothnia, and local records for May +57 cm at Raahe, +54 cm at Pietarsaari, and +47 cm at Vaasa. At the end of the month a centre of high pressure started to strengthen, and the water level began to fall. The monthly mean was 12–20 cm above the long-term average.

June

At the beginning of the month the strong high pressure area still prevailed. Fluctuations were quite mild until at the end of the month, when a low pressure system moved southwards from the White Sea, causing a moderate rise. The monthly mean was 3–10 cm below the long-term average.

July

Low air pressure and unsettled weather conditions mainly prevailed. The sea level fluctuated and rose slowly, until at the end of the month a low pressure system and stormy winds in the southern sea area caused a rise that was exceptional for summer. On 31st July a record value for July, +104 cm, was measured at Hamina, and a local July record, +46 cm, was set at Föglö. The monthly mean was 3–13 cm above the long-term average.

August

The main trend in sea level was a descending one until the end of the month. On 17th–18th August a low pressure centre moved from the Norwegian Sea to the northeast, giving southwesterly winds that caused a temporary rise in the Bay of Bothnia. The monthly mean was 4–12 cm above the long-term averge.

Fig. 7. The Finnish sea level stations.

Kuva 7. Suomen vedenkorkeuden mittausasemat.

Bild 7. Finlands vattenståndsstationer.

September

A number of low pressure centres passed over during the month. The water level rose at first, but by the end of the month it was falling again. On 17th September, strong southwesterly winds forced water into the Bay of Bothnia causing a temporary rise, to +130 cm, at Kemi. The monthly mean was 19–26 cm above the long-term average.

October

Several low pressure areas passed from the northwest, and the water level mainly fluctuated around the long-term average. On 11th–12th October a deep low pressure system moved from the northwest over central Scandinavia, causing strong winds and a rapid fall of water level in the Gulf of Finland on 12th October: at Hamina from a level of about +20 cm in the morning to -80 cm in the evening. The monthly mean differed -5 – +4 cm from the long-term average.

November

The sea level fluctuated averagely around about +20 cm. The monthly mean was 4–12 cm higher than the long-term average.

December

The normal wintry fluctuation of around +20–+30 cm continued. The monthly mean was 7–17 cm higher than the long-term average.

Finnish sea level measurements

The Finnish sea level measurements originate from 13 tide gauge stations operated by the Finnish Institute of Marine Research (Fig. 7). The oldest station was established at Hanko in 1887 and the youngest at Rauma in 1933 (Table 1). The stations are equipped with continuously-functioning recording instruments, and observations are collected automatically in real time. A more detailed description of Finnish sea level recordings is presented in Johansson & al. (2001).

Sea level observations are needed, among other things, for port and route planning, mapping, building activity and navigation. Long-term sea level series are utilized to study possible effects of the climate change on the Baltic Sea level. The data are also very important for studies and estimation of the postglacial land upheaval in Finland.

Merivedenkorkeuden mittaaminen

Suomen vedenkorkeushavainnot tulevat 13 Merentutkimuslaitoksen ylläpitämältä mittausasemalta eli mareografilta (Kuva 7). Vanhin mareografi perustettiin Hankoon vuonna 1887 ja uusin Raumalle 1933 (Taulukko 1). Asemat on varustettu jatkuvatoimisilla rekisteröivillä laitteilla, joilta havaintoja kerätään automaattisesti ja tosiaikaisesti. Tarkempi kuvaus Suomen vedenkorkeushavainnoista on esitetty julkaisussa Johansson & al. (2001).

Vedenkorkeushavaintoja tarvitaan muun muassa satama- ja väyläsuunnittelussa, kartoitus- ja rakennustoiminnassa sekä merenkulkua varten. Pitkien aikasarjojen avulla tutkitaan ilmastonmuutoksen mahdollisia vaikutuksia Itämeren vedenkorkeuteen. Tiedot ovat ensiarvoisen tärkeitä myös jääkauden jälkeisen maankohoamisen tutkimisessa ja määrittämisessä.

Mätning av havsvattenståndet

I Finland gör Havsforskningsinstitutet vattenståndsobservationer vid 13 mätstationer, s.k. mareografer (Bild 7). Den äldsta mareografen grundades i Hangö år 1887 och den yngsta i Raumo 1933 (Tabell 1). Mätstationerna är utrustade med kontinuerligt fungerande apparatur. Observationerna registreras med olika intervaller, den kortaste i det närmaste i realtid, på Havsforskningsinstitutet. En noggrannare beskrivning av Finlands vattenståndsobservationer finns i en publikation av Johansson & al. (2001).

Vattenståndsuppgifter behövs för t.ex. hamn- och farledsplanering, planläggnings- och byggnadsverksamhet samt för sjöfarten. Med hjälp av långa tidsserier forskar man i klimatförändringens eventuella inverkan på Östersjöns vattenstånd. Uppgifterna är också av största vikt i forskningen kring den postglaciala landhöjningen och dess bestämning.

Table 1. The Finnish sea level stations: location, establishment year, and the new Finnish national height system N2000 referred to the height system N60 and to the theoretical mean sea level of 2007 (MW2007).

Taulukko 1. Suomen rannikon vedenkorkeusasemat: sijainti, perustamisvuosi sekä Suomen uuden kansallisen korkeusjärjestelmän N2000 korkeus N60-järjestelmässä ja teoreettisen keskiveden 2007 (MW2007) suhteen.

Tabell 1. Vattenståndstationerna längs Finlands kust: position, grundläggningsår samt Finlands nya nationella höjdsystem N2000 jämfört med höjdsystemet N60 och det teoretiska medelvattnet 2007 (MW2007).

Station/asema/ station	Latitude	Longitude	Established/perustettu grundad year/vuosi/år	N60-N2000 mm	MW2007-N2000 mm
Kemi/Kemi	65°40'	24°31'	1922	411	174
Oulu/Uleåborg	65°02'	25°25'	1922	399	169
Raahe/Brahestad	64°40'	24°24'	1922	425	147
Pietarsaari/Jakobstad	63°43'	22°41'	1921	440	128
Vaasa/Vasa	63°05'	21°34'	1921	434	136
Kaskinen/Kaskö	62°21'	21°13'	1926	425	152
Mäntyluoto/Mäntyluoto	61°36'	21°28'	1925	384	161
Rauma/Raumo	61°08'	21°26'	1933	341	150
Turku/Åbo	60°26'	22°06'	1921	292	160
Föglö/ Föglö	60°02'	20°23'	1923	273	130
Hanko/Hangö	59°49'	22°59'	1887	252	173
Helsinki/Helsingfors	60°09'	24°58'	1904	252	192
Hamina/Fredrikshamn	60°34'	27°11'	1928	212	191

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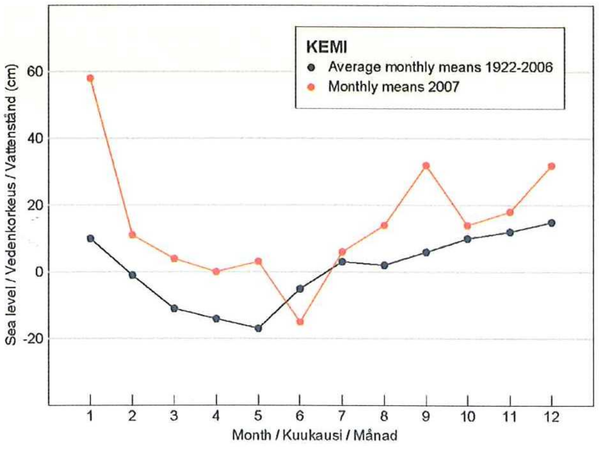
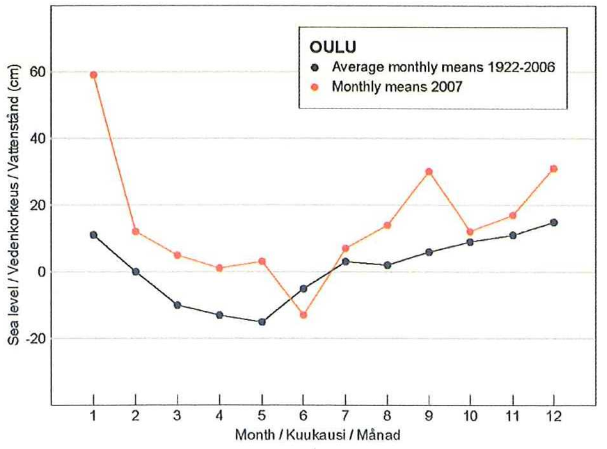
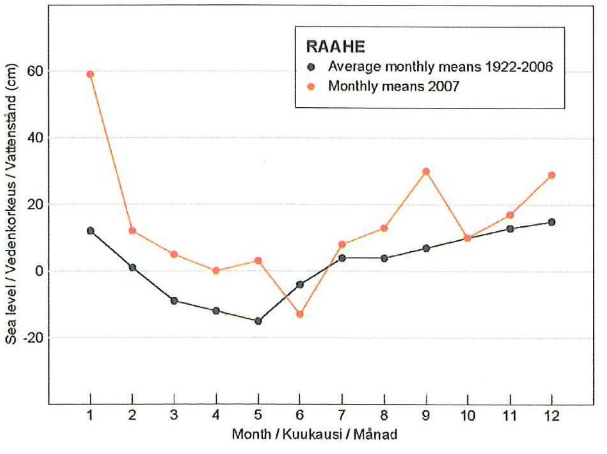
Annex 1. The monthly means of the 2007 sea level heights compared to the average monthly means of all observations up to the end of 2006 in the Bay of Bothnia (Kemi, Oulu, Raahe, Pietarsaari), in the Bothnian Sea (Vaasa, Kaskinen, Mäntyluoto, Rauma), in the Archipelago Sea (Föglö, Turku) and in the Gulf of Finland (Hanko, Helsinki, Hamina), referred to the theoretical mean sea level (cm).

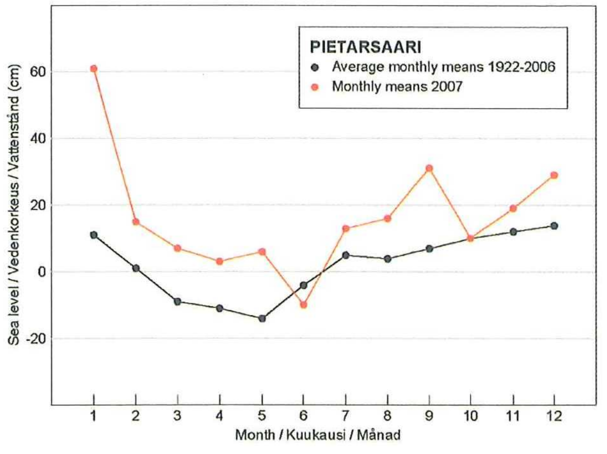
Liite 1. Vedenkorkeuden kuukausikeskiarvot vuonna 2007 verrattuna keskimääräisiin kuukausikeskiarvoihin koko havaintojaksolta vuoden 2006 loppuun Perämerellä (Kemi, Oulu, Raahe, Pietarsaari), Selkämerellä (Vaasa, Kaskinen, Mäntyluoto, Rauma), Saaristomerellä (Föglö, Turku) ja Suomenlahdella (Hanko, Helsinki, Hamina) teoreettisen keskiveden suhteen (cm).

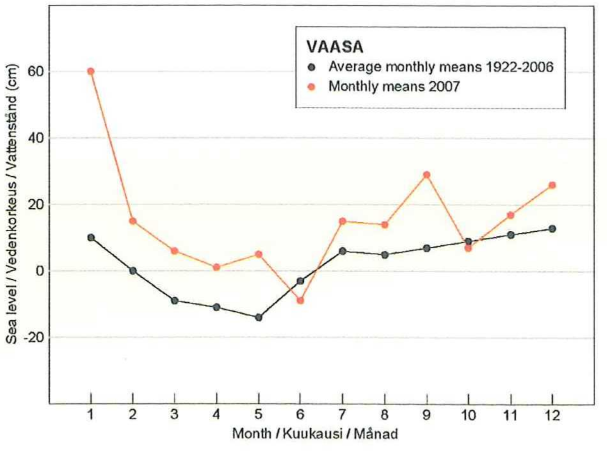
Bilaga 1. Vattenståndets månadsmedelvärden i förhållande till det teoretiska medelvattnet (cm) i Bottenviken (Kemi, Uleåborg, Brahestad, Jakobstad), Bottenhavet (Vasa, Kaskö, Mäntyluoto, Raumo), Skärgårdshavet (Föglö, Åbo) och Finska viken (Hangö, Helsingfors, Fredrikshamn); år 2007 jämfört med hela observationsperiodens genomsnittliga månadsmedelvärden till slutet av år 2006.

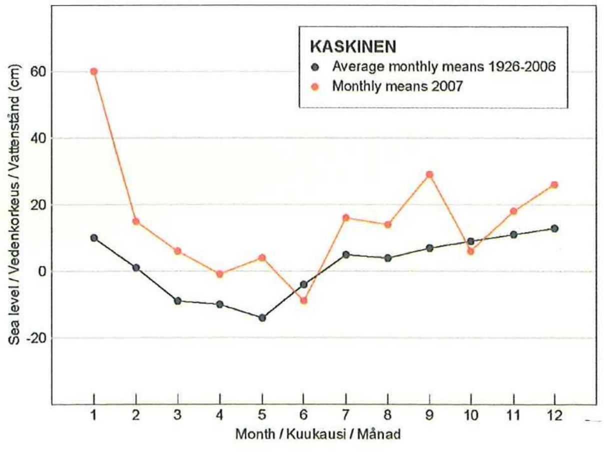


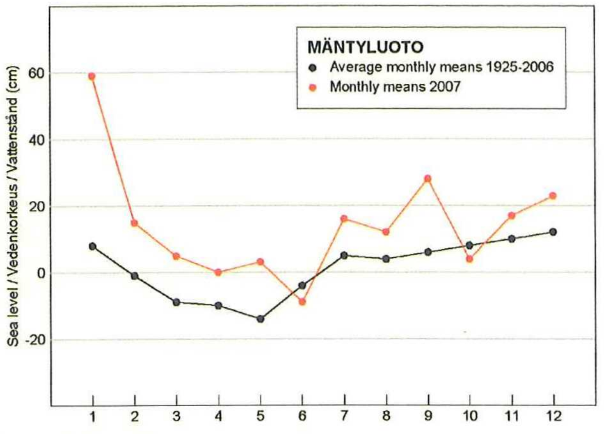


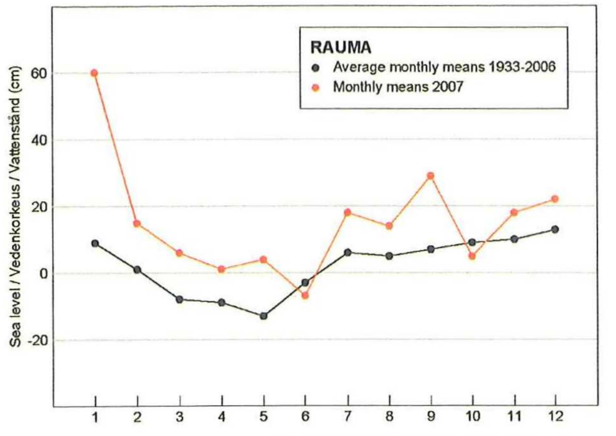


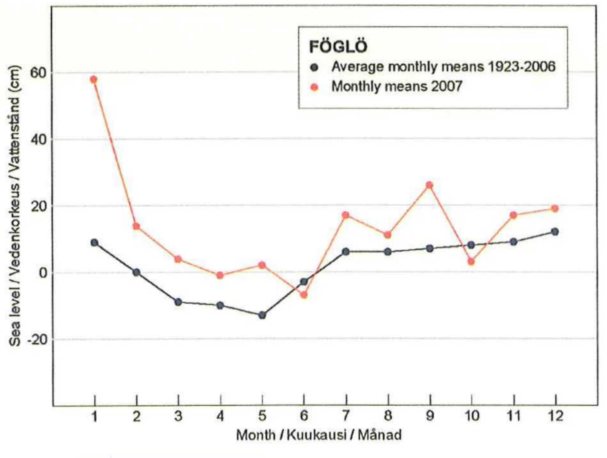


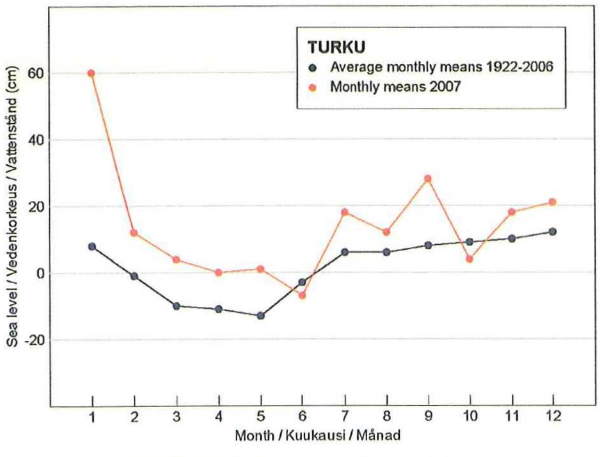


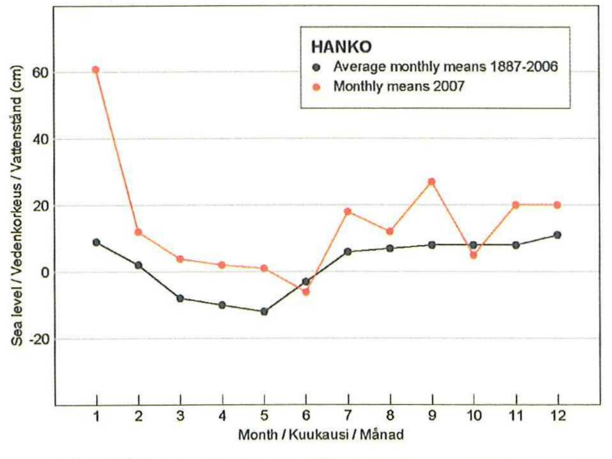


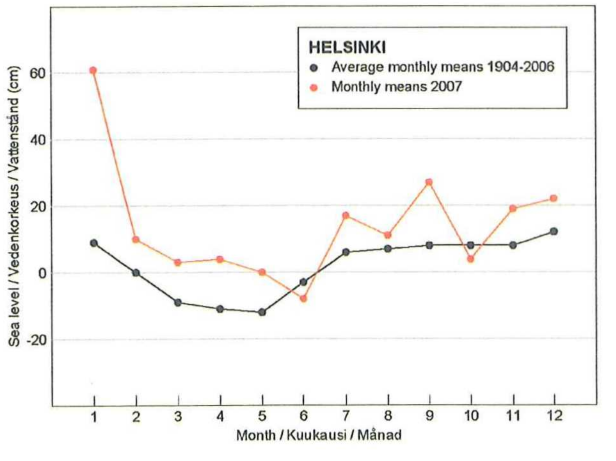

MÄNTYLUOTO
Average monthly means 1925-2006
Monthly means 2007
Sea level / Vedenkorkeus / Vattenstånd (cm)
60
40
20
0
-20
1 2 3 4 5 6 7 8 9 10 11 12

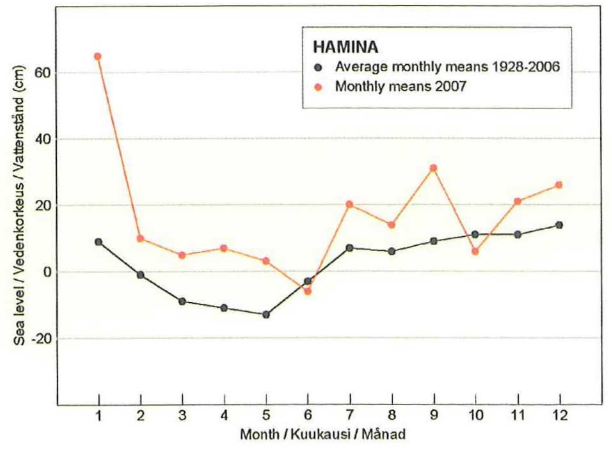

RAUMA
Average monthly means 1933-2006
Monthly means 2007
Sea level / Vedenkorkeus / Vattenstånd (cm)
60
40
20
0
-20
1 2 3 4 5 6 7 8 9 10 11 12


FÖGLÖ
Average monthly means 1923-2006
Monthly means 2007
Sea level / Vedenkorkeus / Vattenstånd (cm)
60
40
20
0
-20
1 2 3 4 5 6 7 8 9 10 11 12
Month / Kuukausi / Månad


TURKU
Average monthly means 1922-2006
Monthly means 2007
Sea level / Vedenkorkeus / Vattenstånd (cm)
60
40
20
0
-20
1 2 3 4 5 6 7 8 9 10 11 12
Month / Kuukausi / Månad


HANKO
Average monthly means 1887-2006
Monthly means 2007
Sea level / Vedenkorkeus / Vattenstånd (cm)
60
40
20
0
-20
1 2 3 4 5 6 7 8 9 10 11 12
Month / Kuukausi / Månad

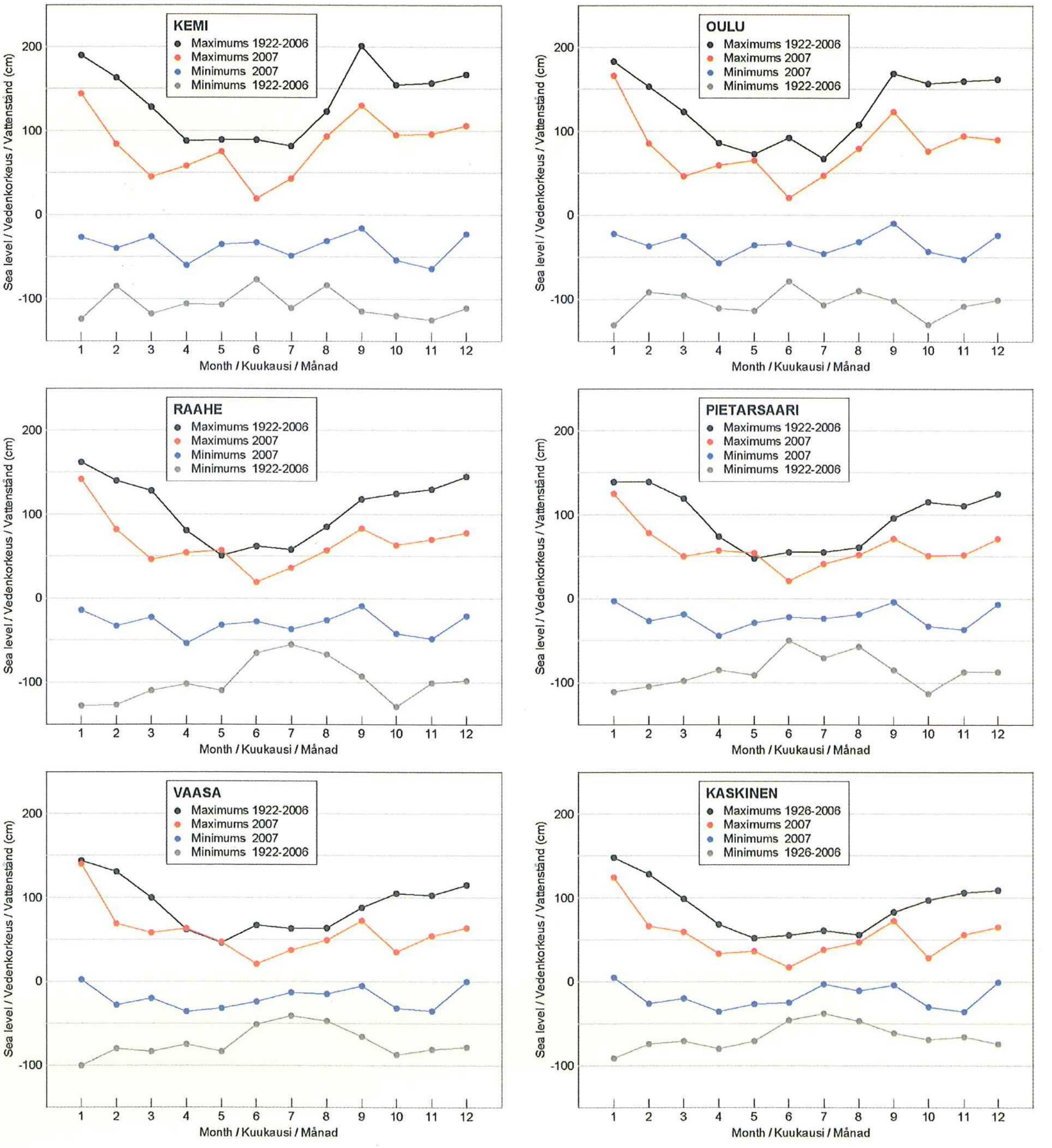

HELSINKI
Average monthly means 1904-2006
Monthly means 2007
Sea level / Vedenkorkeus / Vattenstånd (cm)
60
40
20
0
-20
1 2 3 4 5 6 7 8 9 10 11 12
Month / Kuukausi / Månad

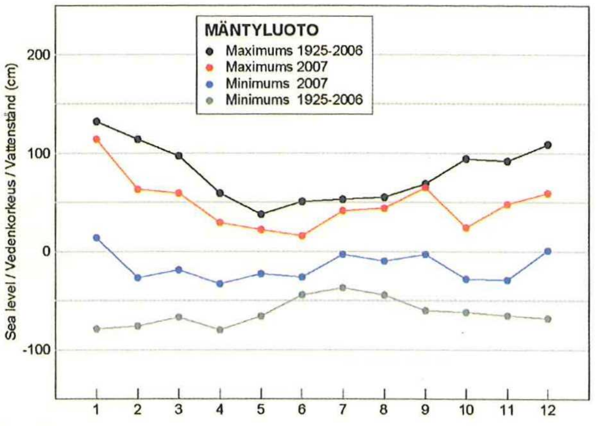

HAMINA
Average monthly means 1928-2006
Monthly means 2007
Sea level / Vedenkorkeus / Vattenstånd (cm)
60
40
20
0
-20
1 2 3 4 5 6 7 8 9 10 11 12
Month / Kuukausi / Månad

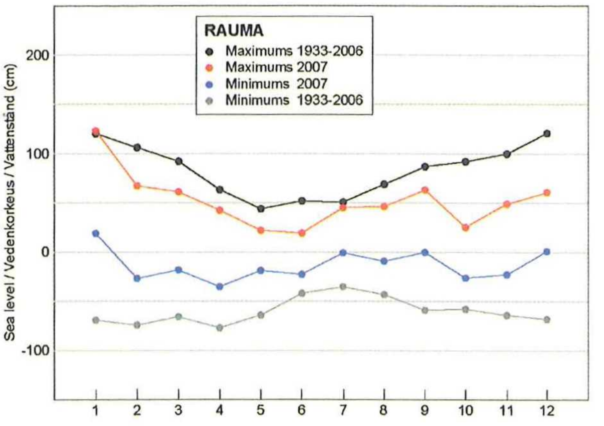
Annex 2. The extreme values of the 2007 sea level heights compared to the extremes of all observations up to the end of 2006 in the Bay of Bothnia (Kemi, Oulu, Raahe, Pietarsaari), in the Bothnian Sea (Vaasa, Kaskinen, Mäntyluoto, Rauma), in the Archipelago Sea (Föglö, Turku) and in the Gulf of Finland (Hanko, Helsinki, Hamina), referred to the theoretical mean sea level (cm).

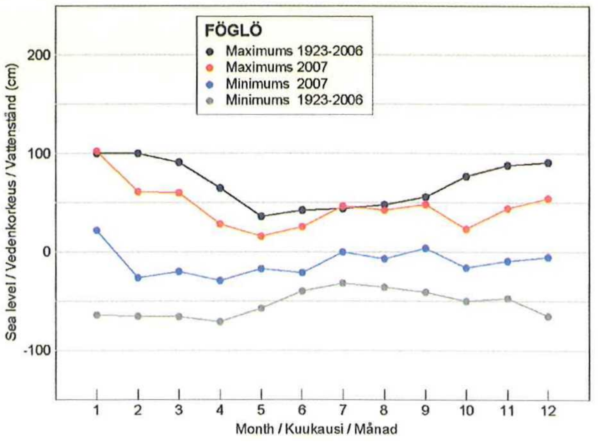
Liite 2. Vedenkorkeuden kuukausiääriarvot vuonna 2007 verrattuna ääriarvoihin koko havaintojaksolta vuoden 2006 loppuun Perämerellä (Kemi, Oulu, Raahe, Pietarsaari), Selkämerellä (Vaasa, Kaskinen, Mäntyluoto, Rauma, Saaristomerellä (Föglö, Turku) ja Suomenlahdella (Hanko, Helsinki, Hamina) teoreettisen keskiveden suhteen (cm).

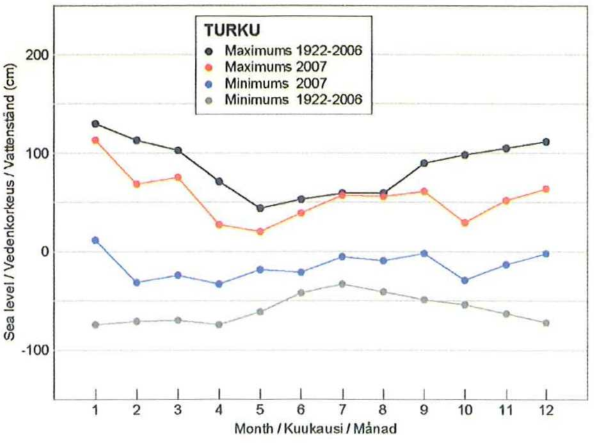
Bilaga 2. Vattenståndets månadsextremvärden år 2007 jämfört med hela observationsperiodens månadsextremvärden till slutet av år 2006, i förhållande till det teoretiska medelvattnet (cm). i Bottenviken (Kemi, Uleåborg, Brahestad, Jakobstad), Bottenhavet (Vasa, Kaskö, Mäntyluoto, Raumo), Skärgårdshavet (Föglö, Åbo) och Finska viken (Hangö, Helsingfors, Fredrikshamn).

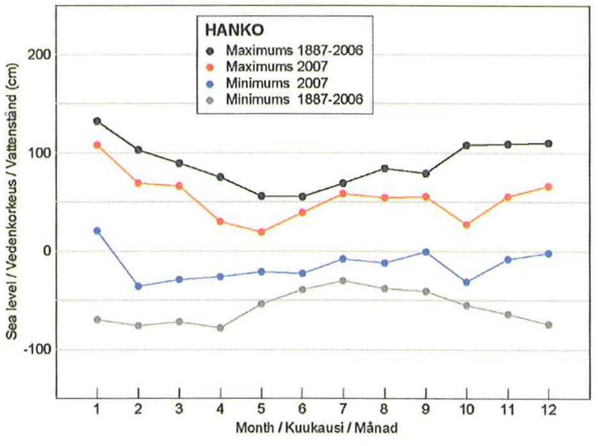


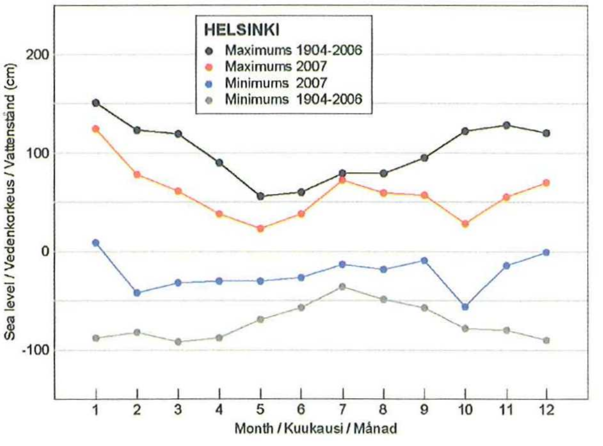

MÄNTYLUOTO
Maximums 1925-2006
Maximums 2007
Minimums 2007
Minimums 1925-2006
Sea level / Vedenkorkeus / Vattenstånd (cm)

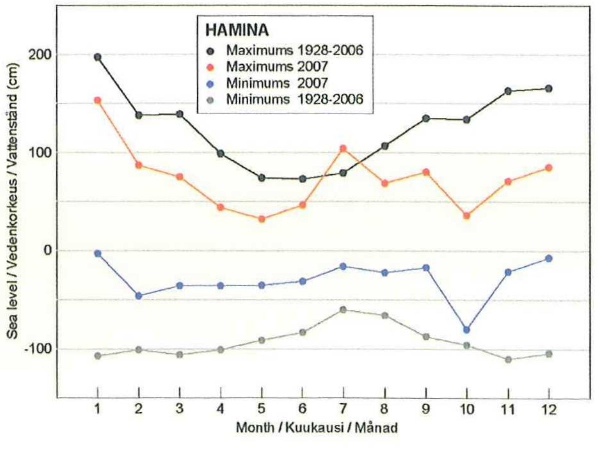

RAUMA
Maximums 1933-2006
Maximums 2007
Minimums 2007
Minimums 1933-2006
Sea level / Vedenkorkeus / Vattenstånd (cm)


FÖGLÖ
Maximums 1923-2006
Maximums 2007
Minimums 2007
Minimums 1923-2006
Sea level / Vedenkorkeus / Vattenstånd (cm)
Month / Kuukausi / Månad


TURKU
Maximums 1922-2006
Maximums 2007
Minimums 2007
Minimums 1922-2006
Sea level / Vedenkorkeus / Vattenstånd (cm)
Month / Kuukausi / Månad


HANKO
Maximums 1887-2006
Maximums 2007
Minimums 2007
Minimums 1887-2006
Sea level / Vedenkorkeus / Vattenstånd (cm)
Month / Kuukausi / Månad

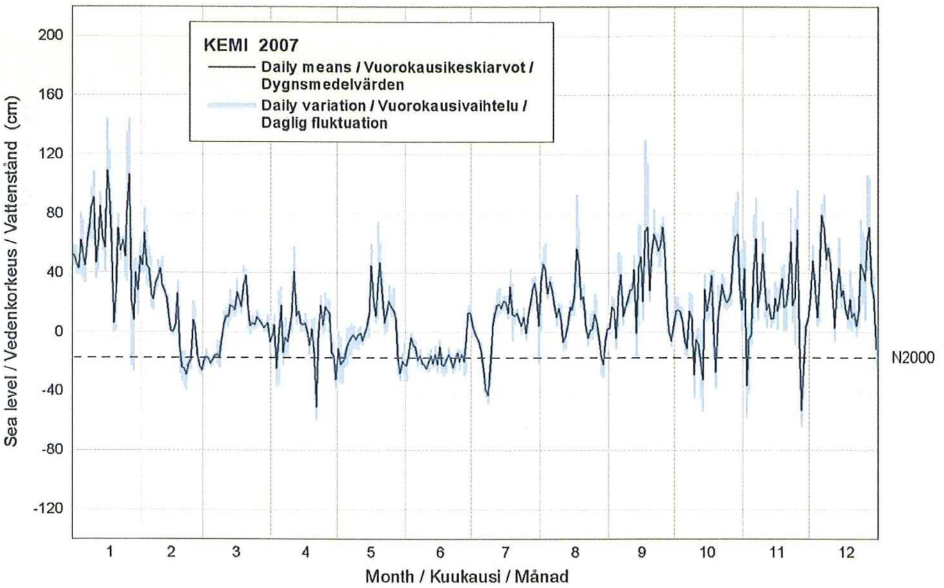

HELSINKI
Maximums 1904-2006
Maximums 2007
Minimums 2007
Minimums 1904-2006
Sea level / Vedenkorkeus / Vattenstånd (cm)
Month / Kuukausi / Månad

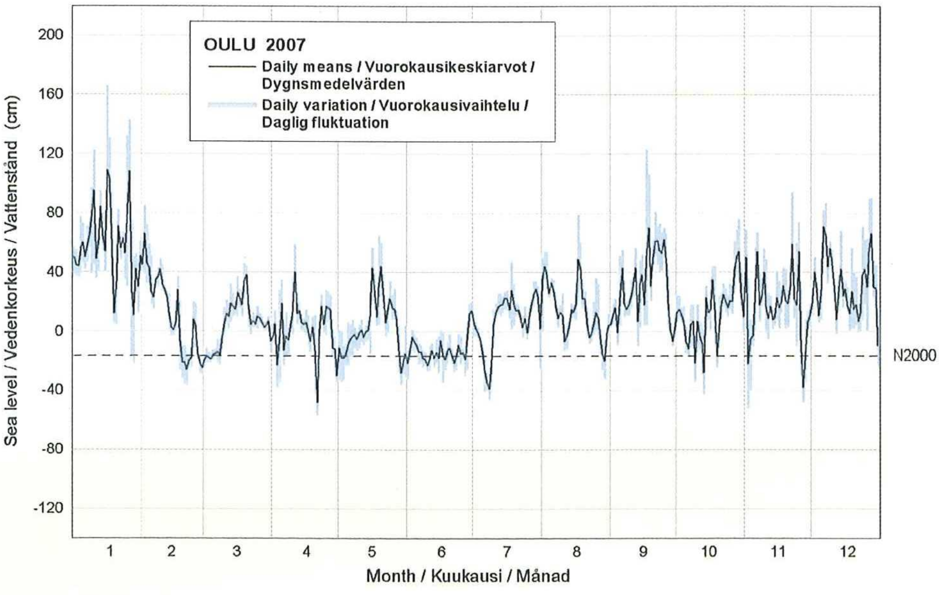

HAMINA
Maximums 1928-2006
Maximums 2007
Minimums 2007
Minimums 1928-2006
Sea level / Vedenkorkeus / Vattenstånd (cm)
Month / Kuukausi / Månad

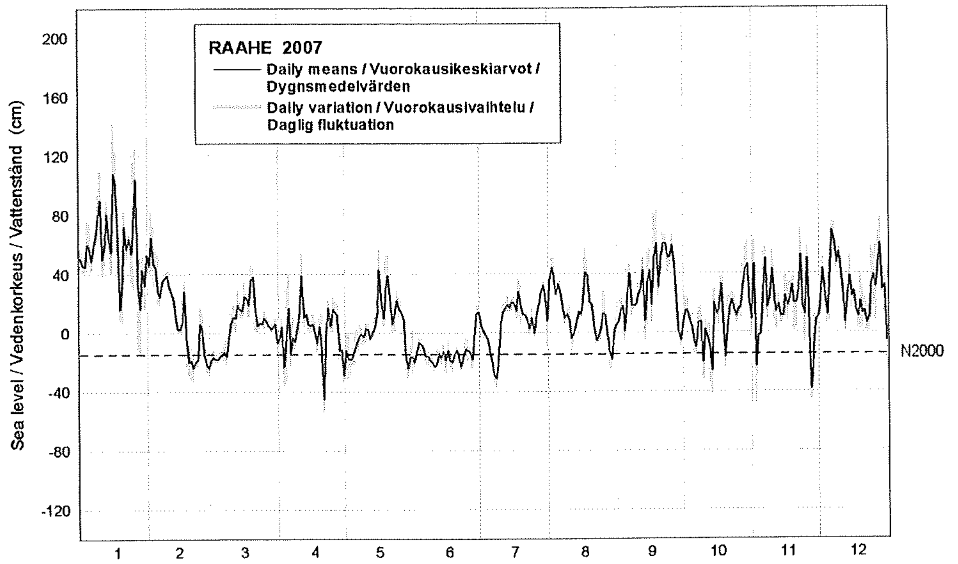
Annex 3. The daily means (black) and the total daily variation (blue) of the 2007 sea level heights, and the height of the new Finnish national reference level N2000 (dashed line), in the Bay of Bothnia (Kemi, Oulu, Raahe, Pietarsaari), in the Bothnian Sea (Vaasa, Kaskinen, Mäntyluoto, Rauma), in the Archipelago Sea (Föglö, Turku) and in the Gulf of Finland (Hanko, Helsinki, Hamina), referred to the theoretical mean sea level of 2007 (cm).

Liite 3. Vedenkorkeuden vuorokausikeskiarvot (musta) ja vuorokauden kokonaisvaihtelu (sininen) vuonna 2007 sekä Suomen uuden kansallisen korkeusjärjestelmän N2000 korkeus (katkoviiva) Perämerellä (Kemi, Oulu, Raahe, Pietarsaari), Selkämerellä (Vaasa, Kaskinen, Mäntyluoto, Rauma), Saaristomerellä (Föglö, Turku) ja Suomenlahdella (Hanko, Helsinki, Hamina), vuoden 2007 teoreettisen keskiveden suhteen (cm).

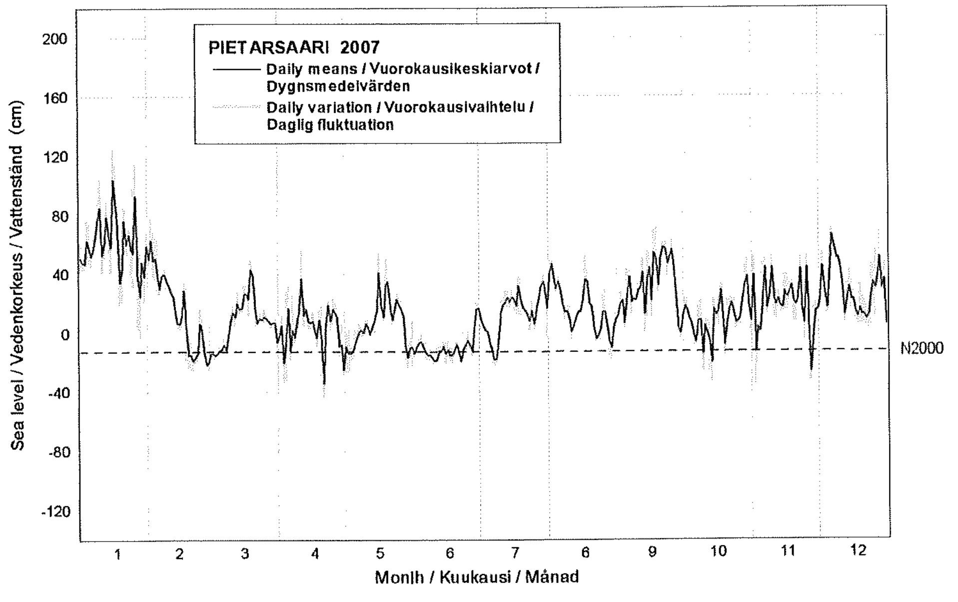
Bilaga 3. Vattenståndets dygnsmedelvärden (svart linje) och totala dagliga fluktuation (blått fält) år 2007 i förhållande till det teoretiska medelvattnet 2007 i Bottenviken (Kemi, Uleåborg, Brahestad, Jakobstad), i Bottenhavet (Vasa, Kaskö, Mäntyluoto, Raumo), i Skärgårdshavet (Föglö, Åbo) och i Finska viken (Hangö, Helsingfors, Fredrikshamn) i förhållande till det teoretiska medelvattnet 2007 (cm). Den streckade linjen indikerar Finlands nya referensnivå, N2000.



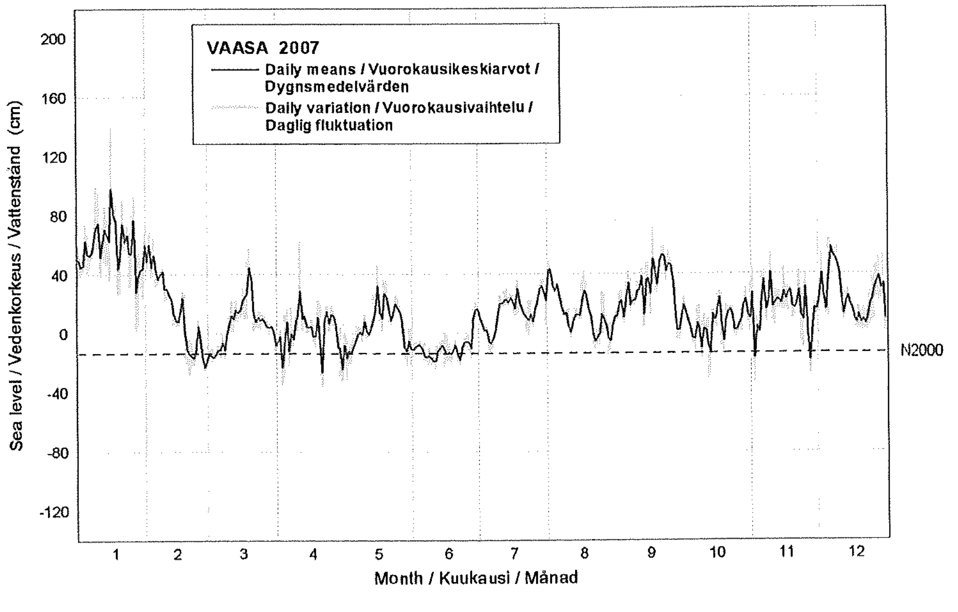




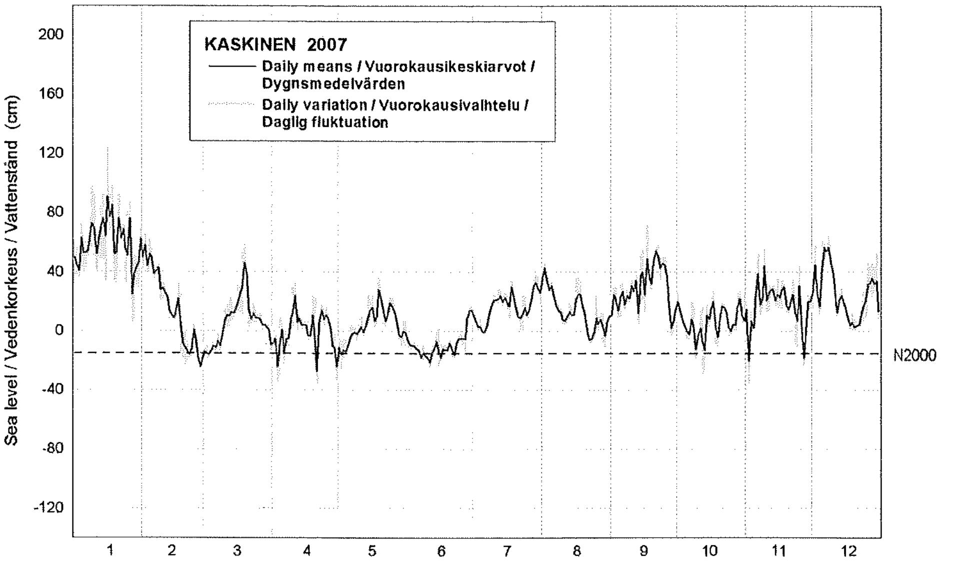
RAAHE 2007
Daily means / Vuorokausikeskiarvot / Dygnsmedelvärden
Daily variation / Vuorokausivaihtelu / Daglig fluktuation
Sea level / Vedenkorkeus / Vattenstånd (cm)
N2000



PIETARSAARI 2007
Daily means / Vuorokausikeskiarvot / Dygnsmedelvärden
Daily variation / Vuorokausivaihtelu / Daglig fluktuation
Sea level / Vedenkorkeus / Vattenstånd (cm)
N2000
Month / Kuukausi / Månad



VAASA 2007
Daily means / Vuorokausikeskiarvot / Dygnsmedelvärden
Daily variation / Vuorokausivaihtelu / Daglig fluktuation
Sea level / Vedenkorkeus / Vattenstånd (cm)
N2000
Month / Kuukausi / Månad


KASKINEN 2007
Daily means / Vuorokausikeskiarvot / Dygnsmedelvärden
Daily variation / Vuorokausivaihtelu / Daglig fluktuation
Sea level / Vedenkorkeus / Vattenstånd (cm)
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N2000
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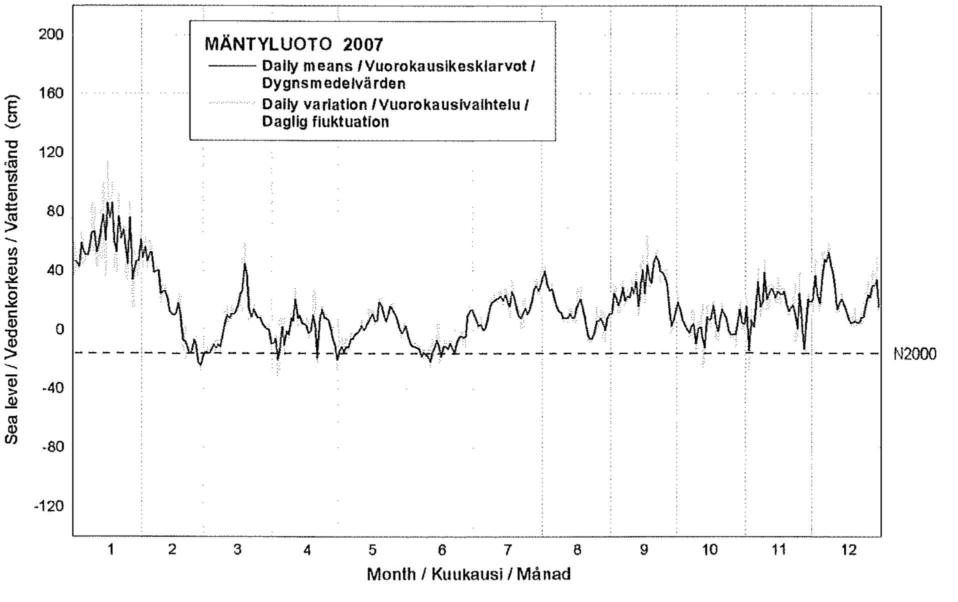
MÄNTYLUOTO 2007
Daily means / Vuorokausikeskiarvot / Dygnsmedelvärden
Daily variation / Vuorokausivaihtelu / Daglig fluktuation
Sea level / Vedenkorkeus / Vattenstånd (cm)
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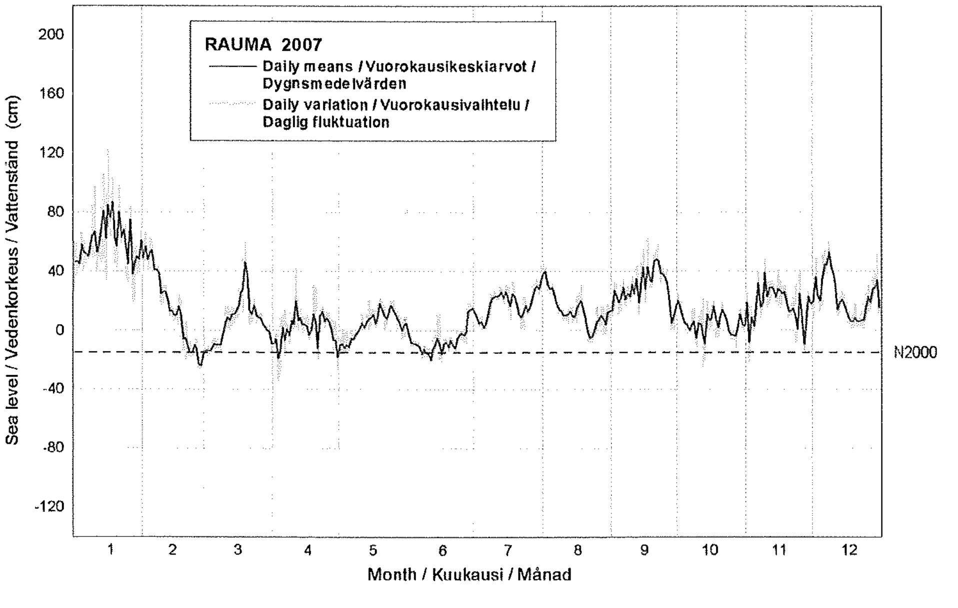
Month / Kuukausi / Månad


RAUMA 2007
Daily means / Vuorokausikeskiarvot / Dygnsmedelvärden
Daily variation / Vuorokausivaihtelu / Daglig fluktuation
Sea level / Vedenkorkeus / Vattenstånd (cm)
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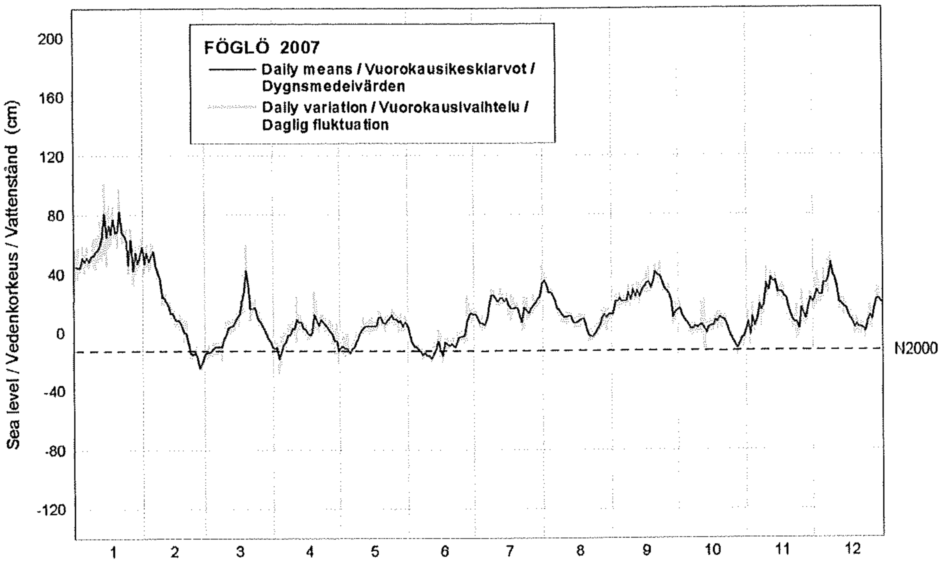
N2000
1 2 3 4 5 6 7 8 9 10 11 12
Month / Kuukausi / Månad


FÖGLÖ 2007
Daily means / Vuorokausikeskiarvot / Dygnsmedelvärden
Daily variation / Vuorokausivaihtelu / Daglig fluktuation
Sea level / Vedenkorkeus / Vattenstånd (cm)
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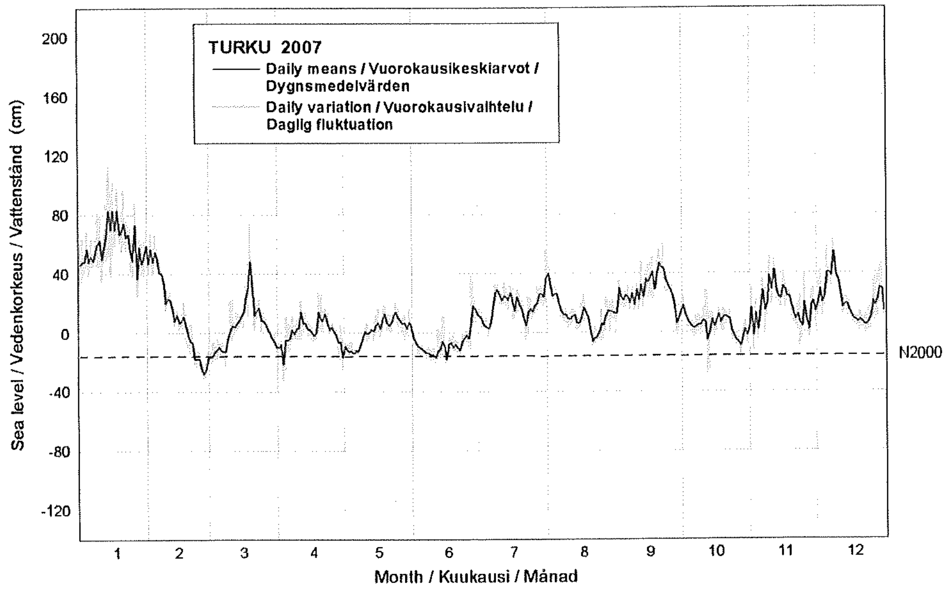
N2000


TURKU 2007
Daily means / Vuorokausikeskiarvot / Dygnsmedelvärden
Daily variation / Vuorokausivaihtelu / Daglig fluktuation
Sea level / Vedenkorkeus / Vattenstånd (cm)
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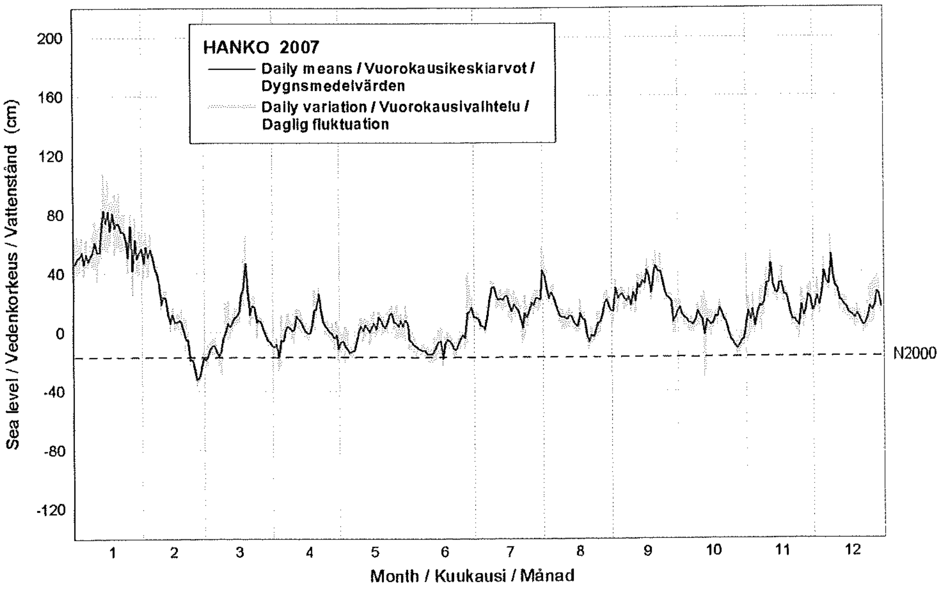
1 2 3 4 5 6 7 8 9 10 11 12
Month / Kuukausi / Månad
N2000


HANKO 2007
Daily means / Vuorokausikeskiarvot / Dygnsmedelvärden
Daily variation / Vuorokausivaihtelu / Daglig fluktuation
Sea level / Vedenkorkeus / Vattenstånd (cm)
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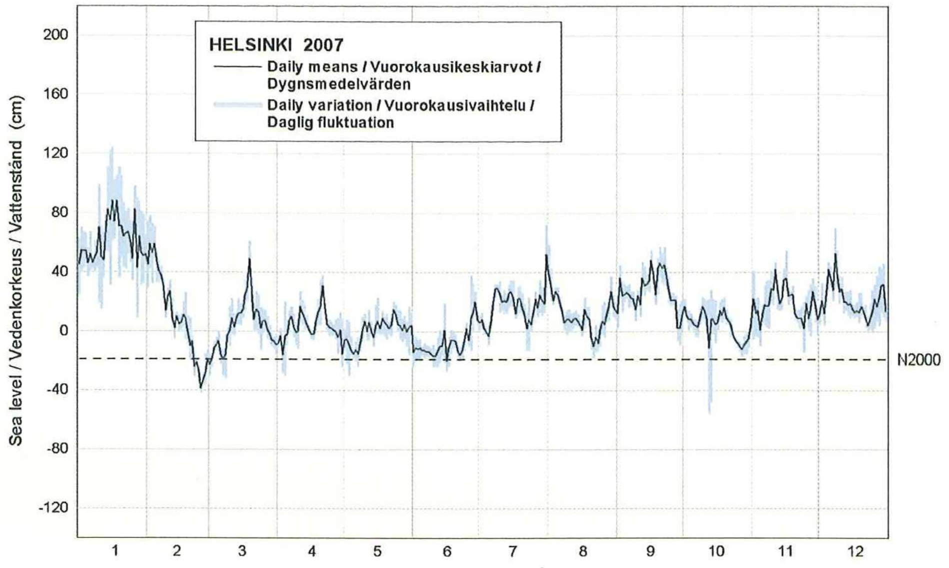
Month / Kuukausi / Månad
N2000


HELSINKI 2007
Daily means / Vuorokausikeskiarvot / Dygnsmedelvärden
Daily variation / Vuorokausivaihtelu / Daglig fluktuation
Sea level / Vedenkorkeus / Vattenstånd (cm)
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N2000
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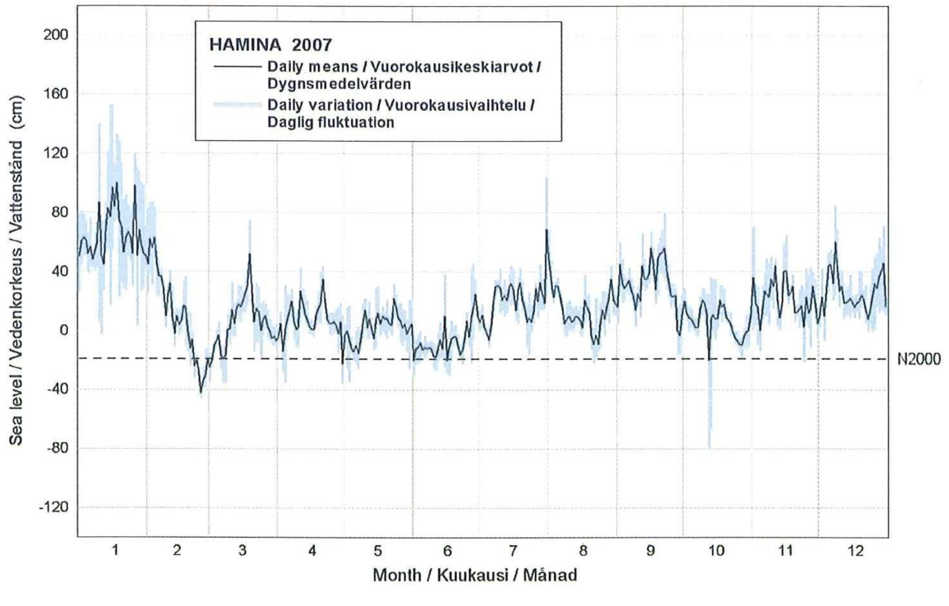
HAMINA 2007
Daily means / Vuorokausikeskiarvot / Dygnsmedelvärden
Daily variation / Vuorokausivaihtelu / Daglig fluktuation
Sea level / Vedenkorkeus / Vattenstånd (cm)
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-80
-120
N2000
1 2 3 4 5 6 7 8 9 10 11 12
Month / Kuukausi / Månad

2. WAVE CLIMATE IN THE NORTHERN BALTIC PROPER AND IN THE GULF OF FINLAND 2007

Heidi Pettersson

In 2007 Finnish Institute of Marine Research measured waves at one location in the Gulf of Finland and at two locations in the Baltic Proper (Fig. 1). The wave climate is described in terms of two parameters, the significant wave height and the wave action depth. The friction at the bottom caused by the wave action can be an important factor when e.g. the sediment resuspension, biota and chemical properties of the benthic boundary layer are considered. As an indicator of the wave action at the three measuring sites, the wave action depth was defined as the depth at which the root-mean-square velocity (Urms) of the waves is 5 cm/s.

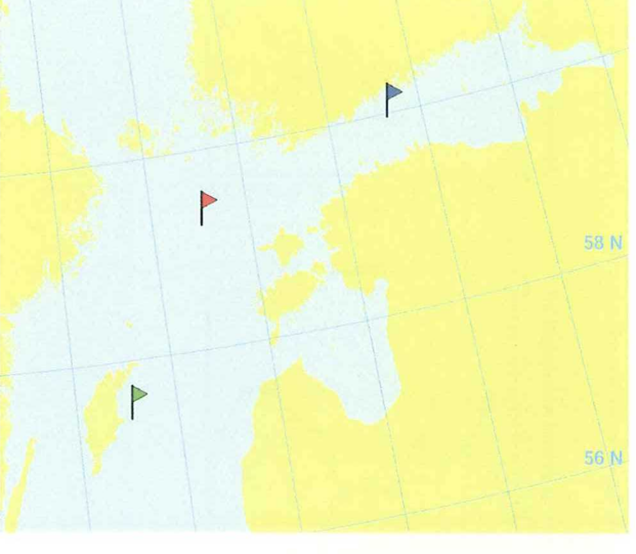

Fig. 1. The wave measuring stations in 2007. Red flag: Northern Baltic Proper (59°15.0' N, 21°00.0' E), blue flag: Helsinki (59°57.9'N, 25°14.1'E) and green flag: Gotland (57°25.'N, 19°03.2'E).

Kuva 1. Aallonmittauspaikat vuonna 2007. Punainen viiri: pohjoinen Itämeri (59°15.0' N, 21°00.0' E), sininen viiri: Helsinki : Helsinki (59°57.9'N, 25°14.1'E) ja vihreä viiri: Gotlanti (57°25.'N, 19°03.2'E).

Bild 1. Vågmätningsplatserna i 2007. Röd vimpel: norra Östersjön (59°15.0' N, 21°00.0' E), blå vimpel: Helsingfors (59°57.9'N, 25°14.1'E) och grön vimpel: Gotland (57°25.'N, 19°03.2'E).

The wave climate in 2007 at the measuring sites is characterised by a stormy January, and a rougher-than-usual April, July, September and December. February and October were calmer than average. No extreme values were measured, the highest significant wave heights being 5.4 metres in the Northern Baltic Proper (January), 4.0 metres in the Gulf of Finland (January) and 4.1 metres off the eastern coast of Gotland (December). In the Gulf of Finland a significant wave height of 3.7 metres was measured at the end of July, a record value for the summer season. The wave action depth was greatest in January, while at the end of the year the wave action did not reach significant depths, especially not in the Gulf of Finland.

January

The wave climate in the Northern Baltic Proper was clearly rougher than usual (Fig. 2, top left panel), the significant wave height being over two metres for half of the time. The significant wave height exceeded five metres three times, with the highest significant wave height, 5.4 metres, being measured on 26 January. The wave action depth was close to or over 60 metres several times (Fig. 3, top panel), and the mean wave action depth was 28 metres (Fig. 4, top left panel). At the more sheltered station of Gotland (Fig. 1), the sea state was also rougher than usual (Fig. 2, bottom panels) even though the significant wave height did not exceed three metres. The buoy was recovered on 22 January for maintenance. In the Gulf of Finland the highest significant wave height in 2007, four metres, was measured on 10 January. It was also a record value for this month. On average, the wave climatewas a little calmer than usual (Fig. 2, middle panels). The wave action depth reached the bottom (62 metres) twice (Fig. 3, middle panel).

February

In the Northern Baltic Proper the sea state was calmer than usual (Figs. 2 and 4) and the significant wave height exceeded three metres only twice. The wave action depth reached 53 meters once (Fig. 3). The buoy in the Gulf of Finland was recovered on 9 February due to the growing ice cover in the area (Chapter 3).

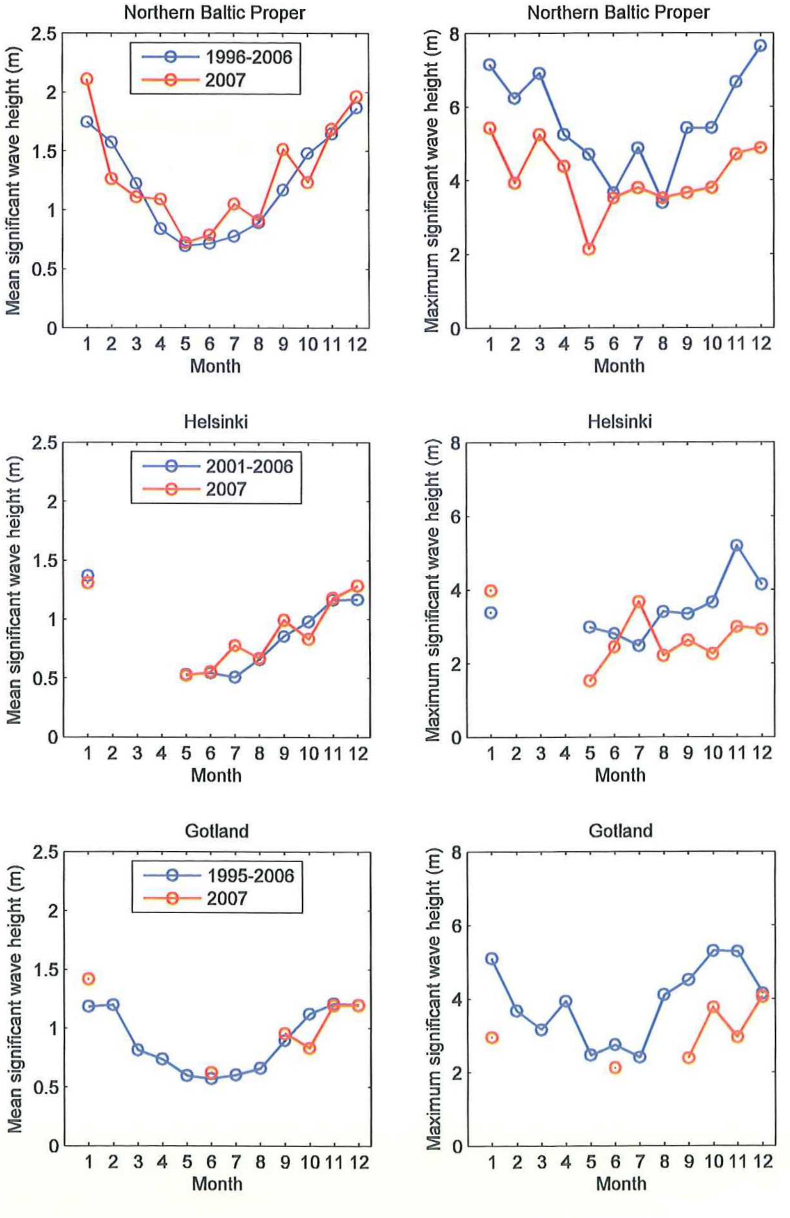

Fig. 2. The monthly means (left panels) and maxima (right panels) of the significant wave height. Top panels: the Northern Baltic Proper station, middle panels: the Helsinki station and the lowest panels: the Gotland station.

Kuva 2. Merkitsevän aallonkorkeuden kuukausikeskiarvot (kuvat vasemmalla) ja kuukauden korkeimmat arvot (kuvat oikealla). Ylimmät kuvat: pohjoinen Itämeri, keskimmäiset kuvat: Helsinki ja alimmat kuvat: Gotlanti.

Bild 3. Månadsmedelvärdena för den signifikanta våghöjden (till vänster) och de högsta värdena för varje månad (till höger). Överst: norra Östersjön, i mitten: Helsingfors och nederst: Gotland.

March

The significant wave height in the Northern Baltic Proper remained under three meters except on 19 March, when a significant wave height of 5.3 metres was measured and the wave action depth reached 100 metres (Figs. 2, 3 and 4).

April

The sea state in the Northern Baltic Proper was rougher than usual and a significant wave height of 4.4 metres was measured on 20 April (Fig. 2). The wave action depth remained less than 52 metres (Figs. 3 and 4).

May

Wave measurements in the Gulf of Finland started again on 3 May. The wave climate in the Northern Baltic Proper and in the Gulf of Finland was typical for the season (Figs. 2 and 4). The significant wave height exceeded two metres in the Northern Baltic Proper and 1.5 metres in the Gulf of Finland only once. May was the calmest month of the year.

June

The wave buoy was redeployed at the Gotland station on 30 May (Fig. 1). At the beginning of the month a significant wave height of 3.5 m was measured in the Northern Baltic Proper and, on average, the wave climate was a little rougher than usual. In the Gulf of Finland the wave climate was typical for the month (Figs. 2 and 4).

Wave measurements

Waves were measured with Directional Waveriders. These surface-following buoys measure the waves and their direction with three accelerometers and a compass. The wave spectrum is calculated on board the buoy from a time series of 1600 s. The measurements were recorded at the receiving stations every 0.5–1 hour. The significant wave height was calculated from the spectrum over a frequency range of 0.05–0.58 Hz.

Aaltomittaukset

Aallokkoa mitattiin Directional Waverider -poijuilla. Nämä pintapoijut mittaavat aallokkoa ja sen suuntaa kolmen kiihtyvyysanturin ja kompassin avulla. Poiju laskee aallokon spektrin 1600 sekunnin aikasarjasta. Poijun tekemät mittaukset talletetaan vastaanottoasemalla 0,5–1,5 tunnin välein. Merkitsevä aallonkorkeus lasketaan spektristä taajuusväliltä 0,05–0,58 Hz.

Vågmätningar

Sjögången mättes med Directional Waverider-vågbojar. Dessa ytbojar mäter vågornas höjd och riktning med hjälp av tre accelerometrar och en kompass. Bojen beräknar vågspektret på basen av en 1600 sekunders tidsserie. Mätningarna lagras på en mottagningsstation med 0,5–1,5 timmars mellanrum. Den signifikanta våghöjden beräknas utgående från spektret på frekvensområdet 0,05–0,58 Hz. För att beräkna profilerna för vågornas orbitalhastigheter delades spektret i åtta frekvensband och den signifikanta våghöjden beräknades för varje band.

July

July was clearly rougher than usual in the Northern Baltic Proper and in the Gulf of Finland (Figs. 2 and 4). The mean significant wave height was over one metre 42 % of the time in the Northern Baltic Proper and 37 % of the time over 0.8 metres in the Gulf of Finland. A record high significant wave height of 3.7 metres was measured off Helsinki on 31 July (Fig. 2). This value is the second highest for the whole of 2007 at this station. At the same time the wave action depth reached 47 metres (Figs. 3 and 4). Due to computer problems, the measurements at the Gotland station in July and August cover only few days (Fig. 3) and no mean values are available.

August

The wave climate in August was typical for the season (Figs. 2 and 4). The significant wave height exceeded three metres once in the Northern Baltic Proper and two metres three times in the Gulf of Finland.

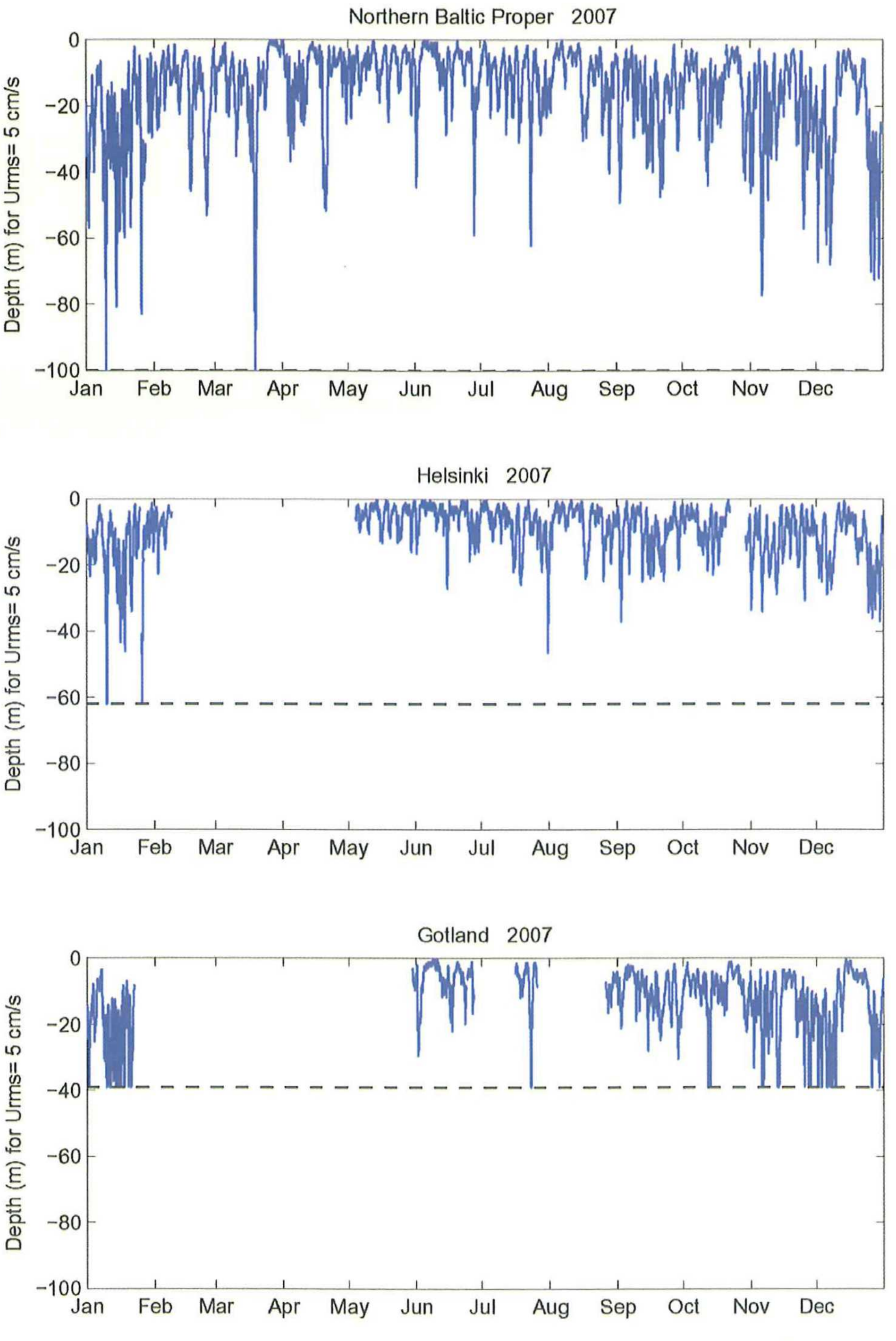

Fig. 3. Time series of the wave action depth. The dashed line indicates the water depth at the measuring site. Top panel: the Northern Baltic Proper station (depth 100 m), middle panel: the Helsinki station (depth 62 m) and the lowest panel: the Gotland station (depth 39 m).

Kuva 3. Aallokon ulottumissyvyyden aikasarjat. Veden syvyys mittauspaikoilla on esitetty katkoviivalla. Ylimpänä pohjoinen Itämeri (syvyys 100 m), keskellä Helsinki (syvyys 62 m) ja alinpana Gotlanti (syvyys 39 m).

Bild 3. Tidsserie för hur djupt vågorna inverkar. Den sträckade linjen anger djupet på mätstationen. Överst norra Östersjön (djup 100 m), i mitten Helsingfors (djup 62 m) och nederst Gotland (djup 39 m).

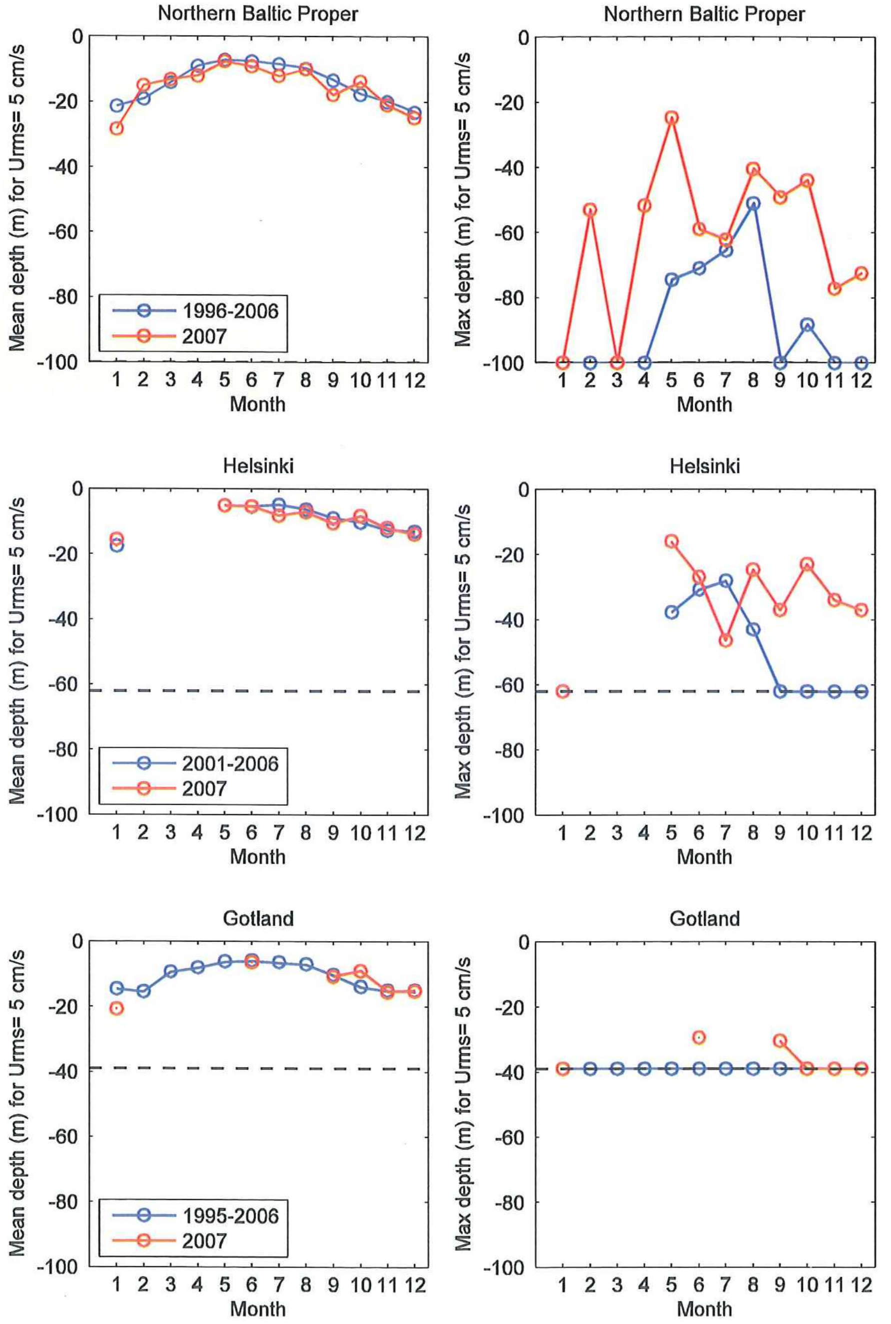

Fig. 4. The monthly means (left panels) and maxima (right panels) of the wave action depth. The dashed line indicates the water depth at the measuring site. Top panels: the Northern Baltic Proper station (depth 100 m), middle panels: the Helsinki station (depth 62 m) and the lowest panels: the Gotland station (depth 39 m).

Kuva 4. Aallokon ulottumissyvyyden kuukausikeskiarvot (kuvat vasemmalla) sekä kuukauden syvimmät ulottuvuudet (kuvat oikealla). Veden syvyys mittauspaikoilla on esitetty katkoviivalla. Ylimmät kuvat: pohjoinen Itämeri (syvyys 100 m), keskimmäiset kuvat: Helsinki (syvyys 62 m) ja alimmat kuvat: Gotlanti (syvyys 39 m).

Bild 4. Månadsmedelvärdena för vågornas djupverkan (till vänster) och de djupaste värdena för varje månad (till höger). Den sträckade linjen anger djupet på mätstationen. Överst: norra Östersjön (djup 100 m), i mitten: Helsingfors (djup 62 m) och nederst: Gotland (djup 39 m).

September

Even though the significant wave height only exceeded 3.5 metres in the Northern Baltic Proper twice and remained under 2.7 metres in the Gulf of Finland, the sea state on average was rougher than usual at both these sites (Fig. 2). At its greatest, the wave action depth reached 37–50 metres (Figs. 3 and 4). At the Gotland station the significant wave height did not exceed 2.4 metres and the average significant wave height was close to the long-term mean value.

October

The wave climate was calmer than is typical for the month at all three measuring sites (Figs. 2 and 4). The significant wave height remained under one metre 78% of the time at the Gotland station, 49% of the time in the Northern Baltic Proper and 69% of the time in the Gulf of Finland.

November

November was again typical for the season. The significant wave height remained under five metres in the Northern Baltic Proper and less than three metres in the Gulf of Finland and at the Gotland station (Figs. 2 and 4).

December

December was a little rougher than usual, and the significant wave height exceeded four metres six times in the Northern Baltic Proper. The highest value was 4.9 metres, measured twice at the end of the month. In the more sheltered station of Gotland, the significant wave height reached four metres once. In the Gulf of Finland the significant wave height did not exceed three metres (Fig. 2). The wave action depth reached 77 m in the Northern Baltic Proper and 37 metres in the Gulf of Finland (Figs. 3 and 4).

Calculation of the wave action depth

The wave field consists of waves with different heights and lengths. The longer the wave is, the deeper its influence penetrates into the water. Due to the irregular nature of waves, the root-mean-square velocity was chosen instead the more often used maximum orbital velocity. The root-mean-square velocities were calculated from a coarse wave spectrum with eight frequency bands in order to resolve the influence of waves of different lengths. The Urms = 5 cm/s corresponds to the critical value of the Shield's parameter (Shields, 1936) for coarse silt (0.06 mm grain size). The friction factor needed to calculate the critical velocity for sediment movement was calculated with the help of the theory of Grant & Madsen (1982), taking into account the settling velocity of the grains and the statistical properties of the wave field.

Acknowledgements

The wave measurements in the Gulf of Finland were carried out in cooperation with the Finnish Maritime Administration and the Port of Helsinki. Prof. Kimmo Kahma (FIMR) is acknowledged for valuable suggestions, Mr Henry Söderman (FIMR) for the deployments of the buoys, Mr. Hannu Jokinen (FIMR) for basic data handling and Mr. Yngve Wakk for maintaining the receiving station in Gotland.

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Shields, A. 1936: Anwendung der Ähnlichkeitsmechanik und der Turbulenzforschung auf die Geschiebebewegung. – Mitteilungen der Preuss. Versuchanst für Wasserbrau and Schiffbau, Berlin, Nr.26.

3. ICE SEASON 2006/2007

Ari Seinä

The Baltic Sea ice season of 2006/2007 could be classified as a mild one (Fig. 2). No freezing at all took place in the southern Baltic Sea. The maximum ice extent reached 139,000 km² (33% of the Baltic Sea was ice-covered) (Fig. 1). During the last 30 years there have been 17 severer and 13 milder seasons.

First freezing took place in early November at approximately the normal time. The ice disappeared from the northern Bothnian Bay in late May, at around the normal time.

The ice season duration was average in the northern Bothnian Bay, more than one month shorter in the southern Bothnian Bay, almost one and a half months shorter in the Quark, and one and a half months shorter in the Bothnian Sea, the Archipelago Sea, and the Gulf of Finland.

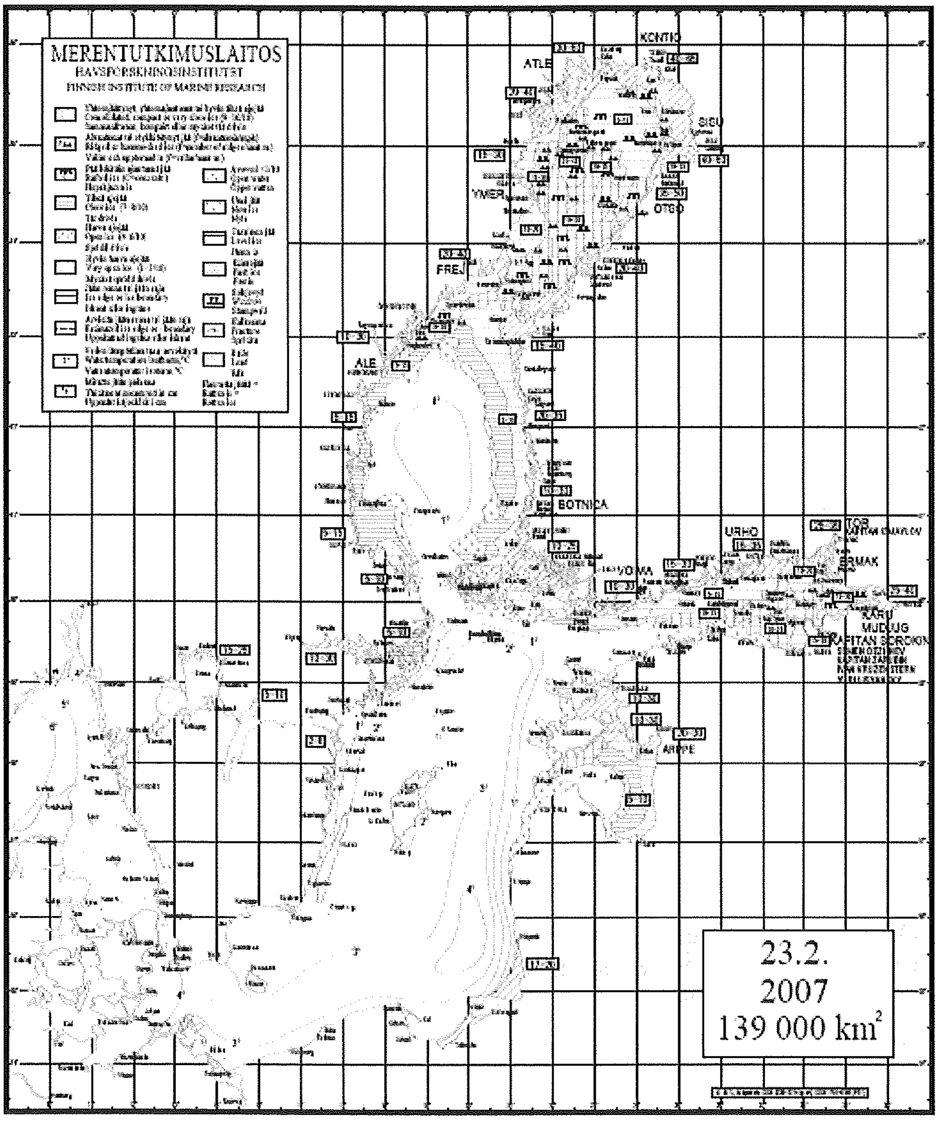

Fig. 1. Maximum ice cover extent in the ice season of 2006/2007.

Kuva 1. Jäätalven 2006/2007 suurin laajuus.

Bild 1. Istäckets maximala utbredning vintern 2006/2007.

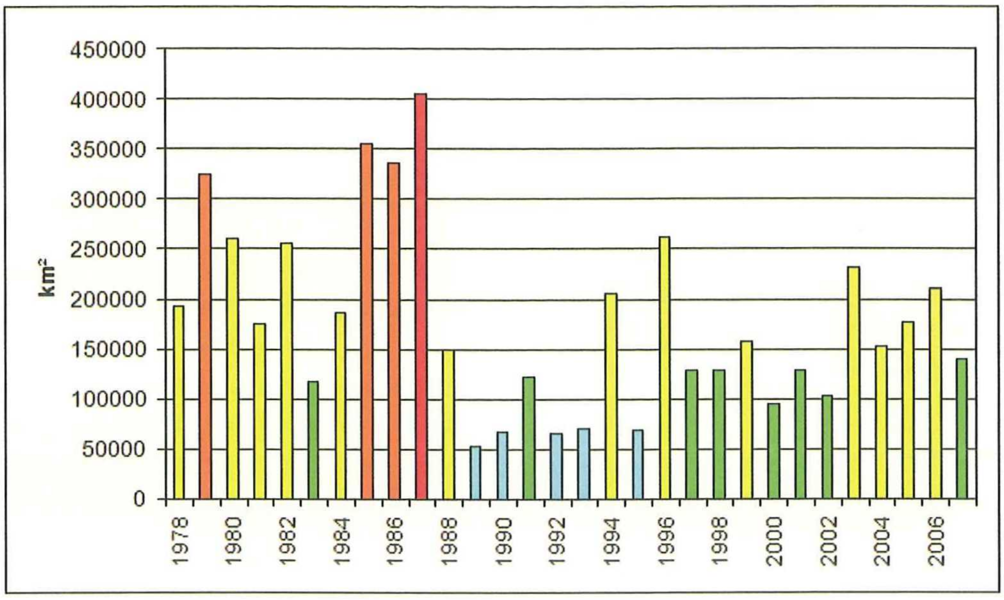

Fig. 2. Maximum ice cover extent in the ice seasons of 1977/1978–2006/2007, and on average (177 000 km²). Blue= extremely mild season, green= mild season, yellow= average season, brown= severe season, and red= extremely severe ice season.

Kuva 2. Jäätalvien 1977/1978–2006/2007 suurin vuotuinen jään laajuus ja keskiarvo (177000 km²). Ice season= jäätalvi. Vaaleansininen = erittäin leuto talvi, vihreä = leuto talvi, keltainen = keskimääräinen talvi, ruskea= ankara talvi ja punainen = erittäin ankara talvi.

Bild 2. Istäckets maximala utbredning under isvintrarna 1977/1978–2006/2007 samt medelvärdet för perioden (177 000 km²). Ice season=isvinter. Ljusblått = extremt mild vinter, grönt = mild vinter, gult = medelkall vinter, brunt = sträng vinter, rött = mycket sträng vinter.

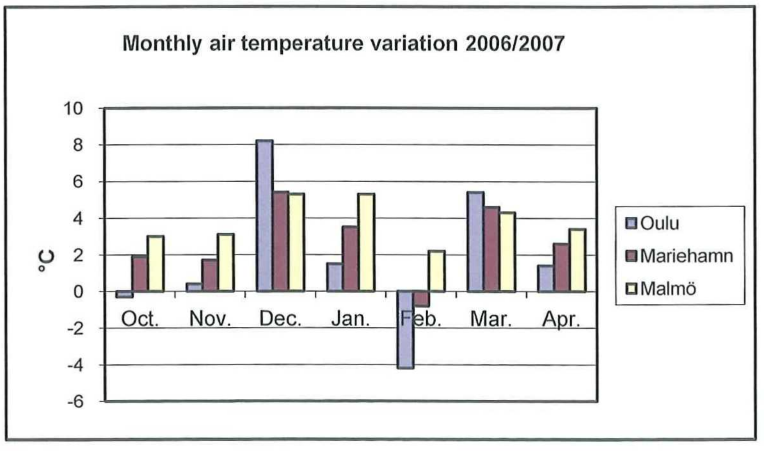

Fig. 3. Variation of monthly air temperatures (relative to the 1961–1990 averages) in the 2006/2007 ice season at Oulu (northern Bothnian Bay), Mariehamn (Åland Sea) and Malmö (southern Sweden).

Kuva 3. Oulun (Perämeren pohjoisosa), Maarianhaminan (Ahvenanmaa) ja Malmön (eteläinen Ruotsi) talven 2006/2007 ilman lämpötilojen kuukausikeskiarvojen erot vuosien 1961–1990 keskiarvoon.

Bild 3. Avvikelserna i lufttemperaturen isvintern 2006/2007 från månadsmedelvärdena för 1961–1990 i Uleåborg (norra Bottenhavet), Mariehamn (Åland) och Malmö (södra Sverige).

In Bilde 3 the variations of the October 2006 – April 2007 monthly air temperatures at Oulu, Mariehamn and Malmö are compared to the 1961–1990 mean average monthly air temperatures. As the Bilde shows, the season started mild: December was record warm. General freezing started as late as February, with the mum ice extent being reached on 23rd of February. March was again very warm. April was near average in the north, and warmer in the south.

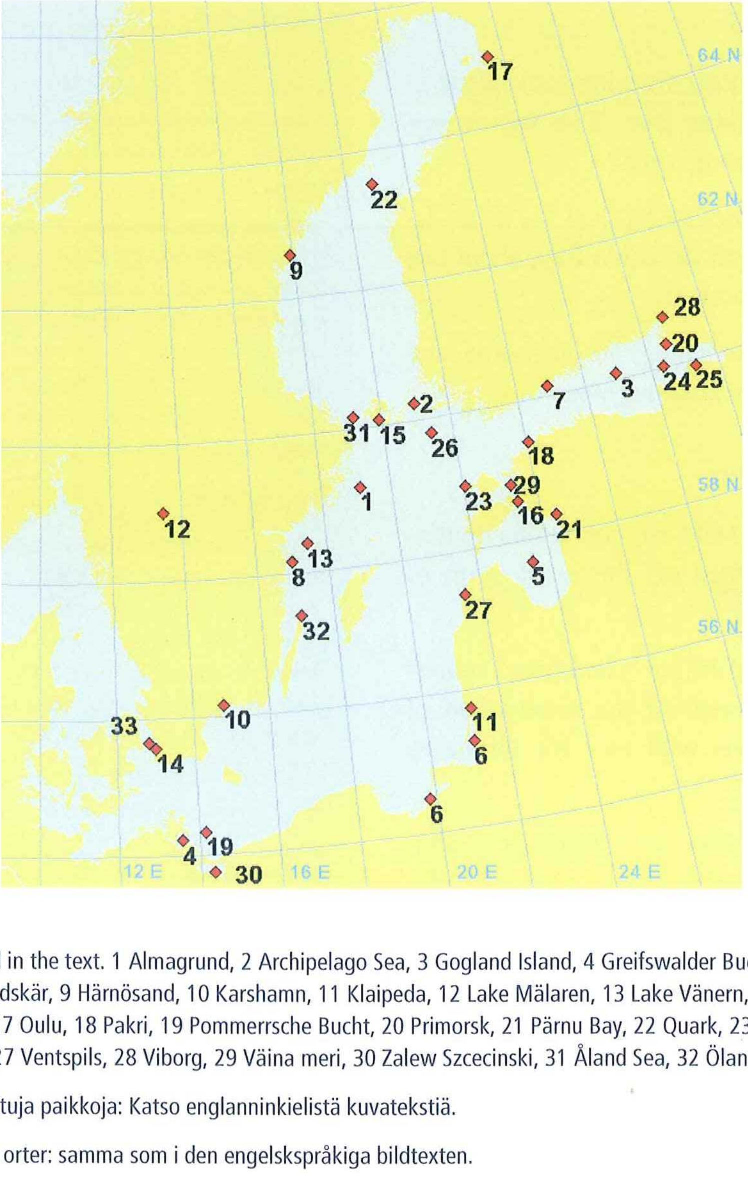

Fig. 4. Places mentioned in the text. 1 Almagrund, 2 Archipelago Sea, 3 Gogland Island, 4 Greifswalder Bucht, 5 Gulf of Riga, 6 Haffs, 7 Helsinki, 8 Häradskär, 9 Härnösand, 10 Karshamn, 11 Klaipeda, 12 Lake Mälaren, 13 Lake Vänern, 14 Malmö, 15 Mariehamn, 16 Moon Strait, 17 Oulu, 18 Pakri, 19 Pommerrsche Bucht, 20 Primorsk, 21 Pärnu Bay, 22 Quark, 23 Ristna, 24 Seskar, 25 St. Petersburg, 26 Utö, 27 Ventspils, 28 Viborg, 29 Väina meri, 30 Zalew Szcecinski, 31 Åland Sea, 32 Öland, 33 Öresund.

Kuva 4. Tekstissä mainittuja paikkoja: Katso englanninkielistä kuvatekstiä.

Bild 4. I texten mämnda orter: samma som i den engelskspråkiga bildtexten.

The Finnish Ice Service

The FIMR is responsible for the sea-ice information service in Finland. This operational service, which started as early as 1915, is intended to meet the needs of national and international shipping as well as other activities where sea ice information is required. These include fisheries, coastal and harbour activities, forecasting and climatology. The Ice Service provides ice information daily and also publishes ice forecasts.

Jääpalvelu

Suomessa Merentutkimuslaitos vastaa merijäätietopalvelusta. Palvelutoiminta alkoi jo vuonna 1915. Palvelu on tarkoitettu vastaamaan sekä kansallisen ja kansainvälisen merenkulun tarpeita että muiden jäätietoa tarvitsevien käyttäjien tarpeita, kuten kalastuksen, satamien, ennustuspalveluiden ja klimatologian. Jääpalvelu julkaisee päivittäin jäätietoa ja -ennusteita.

Istjänsten

I Finland sköts informationen om issituationen havsområdena runt Finland av Havsforskningsinstitutet. Istjänsten inledde sin verksamhet redan år 1915. Tjänsten är avsedd att tjäna både den internationella och nationella sjöfarten på Östersjön samt, också andra som behöver den, till exempel hamnarna, fisket, klimatforskningen och instanser som arbetar med prognoser. Istjänsten publicerar dagligen information om isläget och isprognoser.

November 2006

Early November: First freezing took place in the northern Bothnian Bay. This was at approximately the normal time.

Mid-November: The ice reached the outer islands in the northern Bothnian Bay, about one week earlier than normal.

Late November: Ice conditions decreased, and ice was limited to coastal regions.

December 2006

Early December: Mild ice conditions continued. Ice was situated off the coast north of Oulu.

Mid-December: Mild ice conditions continued. Ice was situated off the coast north of Oulu. Short periods with new ice formation took place.

Late December: Mild ice conditions continued. Ice occurred off the coast north of Oulu. Short periods of new ice took place. First freezing took place in the eastern Gulf of Finland off St. Petersburg, about three weeks later than normal.

Data acquisition

Sea-ice data is collected from several sources: Finnish and Swedish icebreakers report daily and coastal stations send information daily or weekly from 20–30 locations. Ships also provide ice information. Satellites are the most important data source. At the moment the Finnish Ice Service is using NOAA AVHRR, Modis, RADARSAT SAR and Envisat ASAR data.

Sea surface temperatures are measured twice a week at ten coastal stations; in addition, measurements are obtained from automatic stations. Icebreakers and 20–30 merchant vessels with hull thermometers report measurements along their tracks and airborne input data are received from fixed-wing aircrafts making infrared soundings. Spaceborne data from NOAA AVHRR are also used. By these various methods, measurements are obtained covering the whole Baltic Sea.

Tietolähteet

Merijäätietoa kerätään eri lähteistä: suomalaiset ja ruotsalaiset jäänmurtajat raportoivat jäätilanteesta päivittäin, 20–30 jäähavaintoasemaa lähettävät havaintojaan päivittäin tai viikoittain, ja myös laivat lähettävät havaintojaan. Satelliittien havainnot ovat tärkein tietolähde. Tällä hetkellä jääpalvelu käyttää työssään NOAA:n AVHRR-, Modis-, RADARSAT:in SAR- ja Envisatin ASAR-kuvia.

Meren pintavedenlämpötiloja mitataan kymmenellä rannikkoasemalla kaksi kertaa viikossa; jotkin automaattiasemat tekevät myös mittauksia. Jäänmurtajat ja 20–30 kauppalaivaa mittaavat veden lämpötilaa runkolämpömittareiden avulla. Jonkin verran suoritetaan myös mittauksia lentokoneihin asennetuilla infrapunamittareilla. Lämpötilaa mitataan myös NOAA AVHRR-laitteella. Täten mittaukset kattavat koko Itämeren.

Informationskällor

Information om havsisen samlas in från olika källor. De finska och svenska isbrytarna rapporterar dagligen om isläget, och dagligen eller veckovis inflyter uppgifter från 20–30 isobservationslokaler. Också fartygen skickar in isobservationer. Satellitbilder utgör den viktigaste informationskällan. Just nu använder den finska istjänsten bilder från NOAA AVHRR, Modis, RADARSAT SAR och Envisat ASAR.

Ytvattentemperaturen mäts på tio kuststationer två gånger i veckan. En del automatiskt fungerande stationer utför också temperaturmätningar. Isbrytarna och 20–30 handelsfartyg mäter temperaturen med hjälp av skrovtermometrar. I någon mån görs också flygmätningar med instrument för mätning av infraröd strålning. Också NOAA AVHRR-satellitdata används, och sålunda får man data från hela Östersjön.

January 2007

Early and mid-January: Mild weather continued. In the Bothnian Bay, and off St. Petersburg there was occasional new ice formation.

Late January: The weather turned colder, and general ice formation started. On the 19th of January the ice edge in the northern Bothnian Bay reached the latitude of Kemi 1, the Quark archipelago became ice-covered, and new ice formation started off the coast of the eastern Gulf of Finland. By the 25th, half of the Bothnian Bay was ice-covered, the Quark was ice-covered, there was ice formation along the whole Finnish coast, as well as rapid ice formation in the eastern parts of the Gulf of Finland and in Pärnu Bay. After that, ice formation ceased, and the ice edge withdrew near the coasts. Some days later ice formation started again. Over the outer sea area of the northern Bothnian Bay the ice was only 5–10 cm thick.

February 2007

Early February: Half of the Bothnian Bay was ice-covered, the Quark was ice-covered, there was ice along the whole Finnish coast and rapid ice formation in the eastern parts of the Gulf of Finland; in the eastern Gulf of Finland, ice reached Motshjnyj Island, and the coasts in Riga Bay were frozen. Ice formation started in Lake Väneren. By the 8th, the Bothnian Bay was totally ice-covered, there was ice formation along the Swedish coast from the north as far south as Öland Island, while the Gulf of Finland was ice-covered from the east as far west as Gogland Island.

Mid-February: The Bothnian Bay and the Quark were ice-covered to the latitude of Vaasa (about one month later than normal), while in the Bothnian Sea ice extended 10–15 nautical miles off the coast (also about one month later than normal); the Swedish coast was ice-covered all the way from the north to Öland Island, the Archipelago Sea was ice-covered (2–3 weeks later than normal), the Gulf of Finland was ice covered from the east to Gogland Island (about three weeks later than normal), while in the Gulf of Riga there was ice along the eastern coast for a distance of 10–20 nautical miles north of Riga.

Late February: The maximum extent of the ice cover, 139,000 km^2, was reached on the 23rd. On that day, the Gulf of Bothnia and the Quark were totally ice-covered, in the Bothnian Sea ice extended 10–30 nautical miles off the coast, the Archipelago Sea was ice-covered, the Swedish coast was ice covered all the way from the north to Öland Island, while in the Gulf of Finland the ice-edge was situated along a line Utö – Mohni; the Gulf of Riga was almost totally ice-covered, and along the Lithuanian and Latvian coasts north of Klaipeda there was new ice (Fig. 1). In the outer sea areas, the ice thickness was 5–40 cm in the northern Bothnian Bay, 10–35 cm in the southern Bothnian Bay, 5–30 cm in the northern Bothnian Sea, 5–15 cm in the western Gulf of Finland, 10–30 cm in the eastern Gulf of Finland and 5–30 cm in the Gulf of Riga.

March 2007

Early March: With only short periods of freezing occurring, the ice cover started to decrease. With strong winds, ridging was heavy, especially in the Bothnian Bay.

Mid-March: The Bothnian Bay, the Quark, and the northern Bothnian Sea were ice-covered to the latitude of Härnösand, otherwise there was only narrow fast ice off the coast of the Bothnian Sea, while the ice in the Archipelago sea become rotten; the Gulf of Finland was mostly open with the ice accumulated to the northeast of Gogland, while in the Bay of Riga only the northern part was ice-covered. Lake Vänern was almost ice-free.

Late March: The Bothnian Bay, the Quark, and the northern Bothnian Sea were ice-covered to the latitude of Vaasa, otherwise only a narrow belt of rotten fast ice was found off the coast of the Bothnian Sea; the Archipelago Sea was partly open and its remaining ice was rotten, while the Gulf of Finland was mostly open with the ice accumulated to the northeast of a line Porvoo – Schepelewski. The Gulf of Riga was almost ice-free, with only drifted rotten ice off the northern coast. Lake Vänern became ice-free. In the outer sea areas the ice thickness was 20–40 cm in the northern Bothnian Bay, 10–40 cm in the southern Bothnian Bay, 5–30 cm in the northern Bothnian Sea and 15–35 cm in the eastern Gulf of Finland.

Output production

Ice charts covering the Baltic Sea, the Kattegat, the Skagerrak and the large Swedish lakes are issued daily throughout the ice season. Charts are available on the Internet, and on request by other means.

Bulletins on ice conditions including restrictions to navigation, operational areas of icebreakers and traffic information are available on the Internet, and on request by other means. Plain-language ice information is also broadcast daily.

Tietotuotteet

Jääkarttoja, jotka kattavat Itämeren, Kattegatin, Skagerrakin ja Ruotsin suuret järvet, julkaistaan päivittäin jäätalven aikana. Ne ovat saatavilla internetistä ja tilattavissa muilla keinoin toimitettuina.

Jäätiedotukset, jotka sisältävät jäätilannekuvauksen, meriliikennerajoitukset, jäänmurtajien toiminta-alueet ja meriliikennetilanteen ovat saatavilla internetistä ja tilattavissa muilla keinoin toimitettuina. Jäätiedotukset lähetetään myös päivittäin radiossa.

Informationsprodukter

Iskartor, vilka täcker Östersjön, Kattegat, Skagerrak och de stora svenska sjöarna publiceras dagligen under isvintern. De finns tillgängliga på internet och kan även beställas i annat utförande.

Israpporter, vilka omfattar information om isläget, begränsningarna i sjötrafiken, i vilket område isbrytarna opererar samt sjötrafiksituationen, finns på internet och kan även beställas i annan form. Israpporterna uppläses också dagligen i radio.

April 2007

Early April: The southern Bothnian Bay become mostly open (about one month earlier than normal), while the following became ice-free: the Bothnian Sea (about three weeks earlier than normal), the Archipelago Sea (about two weeks earlier than normal), the Gulf of Finland (about two weeks earlier than normal) and the Gulf of Riga (about one month earlier than normal).

Mid-April: The ice in the Bothnian Bay was accumulated in the northeast part, north of a line Kokkola – Luleå. The remaining ice near the coast in the south was rotten.

Late April: The ice in the southern Bothnian Bay melted. Otherwise the ice in the Bothnian Bay was accumulated northeast of a line Kokkola – Luleå. The ice thickness in the outer sea areas was 20–50 cm, heavily ridged in places.

May 2007

Early May: The only remaining ice in the Bothnian Bay was off the Finnish coast north of Kokkola. The ice was partly rotten with heavy ridges.

Mid-May: The fast ice had melted. The remaining ice in the Bothnian Bay was northeast of a line Kokkola – Luleå. The ice was mostly rotten, with scattered heavy ridges.

Late May: By the end of the month all the ice had melted, at about the normal time.

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Seinä, A. & Peltola, J. 1991: Duration of the ice season and statistics of fast ice thickness along the Finnish coast 1961-1990. – Finnish Mar. Res. 258:1-46.

Seinä, A. & Palosuo, E. 1996: The classification of the maximum annual extent of ice cover in the Baltic Sea 1720-1995. – Meri – Report series of Finnish Institute of Marine Research 27: 79-91.

Ilmatieteen laitos 2006-07: Pikatilasto.

SMHI 2006-07: Vatten och väder.

4. HYDROGRAPHY, OXYGEN AND NUTRIENT CONDITIONS

Pekka Alenius, Hannu Haahti & Riikka Hietala

Temperature and salinity are the fundamental physical parameters for seawater because they determine the density and, through that, the dynamics of the water masses, thus affecting many chemical and biological processes. The presence of oxygen is essential for life, and its concentration affects many chemical processes. Especially the near-bottom oxygen concentration is of importance, because the deep waters are isolated from the direct gas exchange between the atmosphere and the sea surface. Thus poor near-bottom oxygen conditions indicate poor ventilation of the sea area in question. Nutrient concentrations are highest in the winter when there is no primary production consuming the nutrients. Thus the winter concentrations are good indicators of the eutrophication of the sea, and they also indicate the potential for the next spring blooms.

Two nutrient compounds, phosphate and combined nitrate+nitrite are used as indicators of eutrophication. In this report we give the wintertime vertically-averaged values of both of these parameters. The vertical average is calculated simply from the integrated area under the vertical curve of the values divided by the depth to the deepest observation.

Ravinneparametrit fosfaatti ja yhdistetty nitraatti+nitriitti on valittu kuvaamaan meren rehevöitymistä. Tässä raportissa esitetään molempien parametrien talviaikainen syvyyskeskiarvo. Syvyyskeskiarvo on laskettu jakamalla parametria kuvaavan käyrän alle jäävä pinta-ala veden syvyydellä alimpaan havaintosyvyyteen asti.

Två närsalter, fosfat och kombinerat nitrat+nitrit, används som indikatorer på övergödning. I den här rapporten presenteras vintermedelvärdet för båda parametrarna integrerat över olika djup. Det här medelvärdet beräknas genom att integrera ytan under kurvan som beskriver närsaltshalten vid olika djup och dividera med djupet för den djupaste observationen.

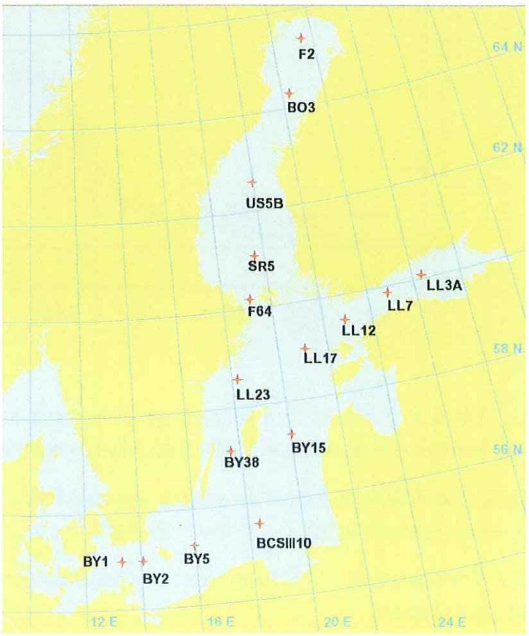


Fig. 1. Standard monitoring stations of the Finnish Institute of Marine Research.

Kuva 1. Merentutkimuslaitoksen tärkeimmät seurantapisteet Itämerellä.

Bild 1. Havsforskningsinstitutets standardstationer för uppföljning av Östersjöns tillstånd

Gulf of Bothnia

The sea surface temperature (SST) in the Bothnian Bay was rather normal at the beginning of 2007. However, in the Bothnian Sea the sea surface temperature was exceptionally high in January (2°C in comparison to the normal 0°C). The spring started earlier than usually. At the end of March and in April the SST was much above average. The warming in the early summer was strong, a development that ended in June and earlier in the north than in the south. In July the temperatures rose again till mid-August. The warm period in August was rather normal for the season, the SST being around 18–22°C). The autumn cooling was normal till the end of the year.

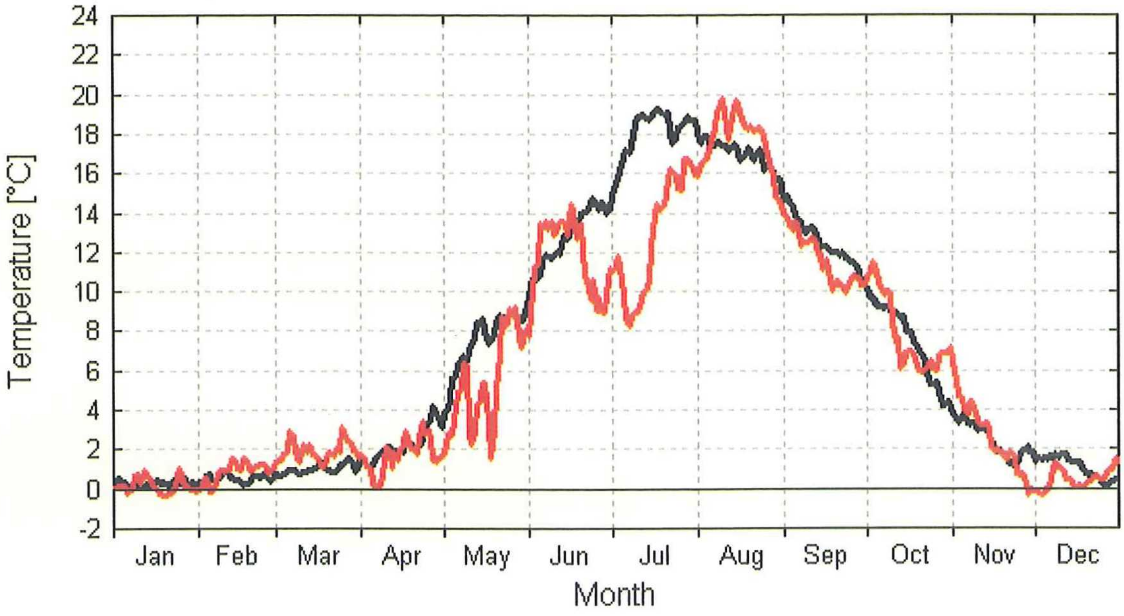


Fig. 2. Variation in near-surface temperature at the coast in the Bothnian Bay/Raahe in 2007 (red, variable curve) in comparison to the average annual course in 1999–2006 (black, smoother curve).

Kuva 2. Rannikkoveden lämpötilan vaihtelu Perämerellä/Raahe vuonna 2007 (punainen, vaihteleva käyrä) verrattuna keskimääräiseen vuotuiseen vaihteluun vuosina 1999–2006 (musta, tasaisempi käyrä).

Bild 2. Yttemperaturen vid Bottenvikens kust (Brahestad) år 2007 (den röda kurvan) jämfört med medelvärdet för 1999–2006 (den svarta kurvan).

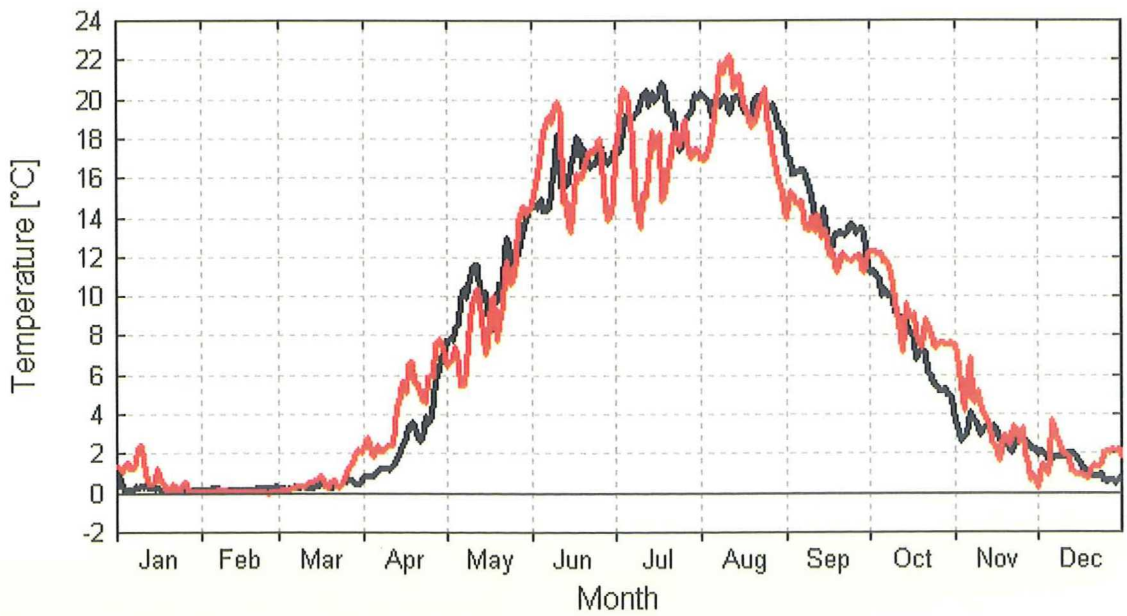


Fig. 3. Variation in near-surface temperature at the coast in the Bothnian Sea/Mäntyluoto in 2007 (red, variable curve) in comparison to the average annual course in 2002–2006 (black, smoother curve).

Kuva 3. Rannikkoveden lämpötilan vaihtelu Selkämerellä/Mäntyluoto vuonna 2007 (punainen, vaihteleva käyrä) verrattuna keskimääräiseen vuotuiseen vaihteluun vuosina 2002–2006 (musta, tasaisempi käyrä).

Bild 3. Yttemperaturen vid Bottenhavets kust (Mäntyluoto) år 2007 (den röda kurvan) jämfört med medelvärdet för 2002–2006 (den svarta kurvan).

The deep-water temperatures (around 4°C) were higher than the long-term averages, but in deep water the absolute variations are generally small.

The salinity in the Gulf of Bothnia was in 2007 at the same level as in the previous couple of years. The situation has already remained the same for several years, but the general level of salinity is smaller than before the 1990's.

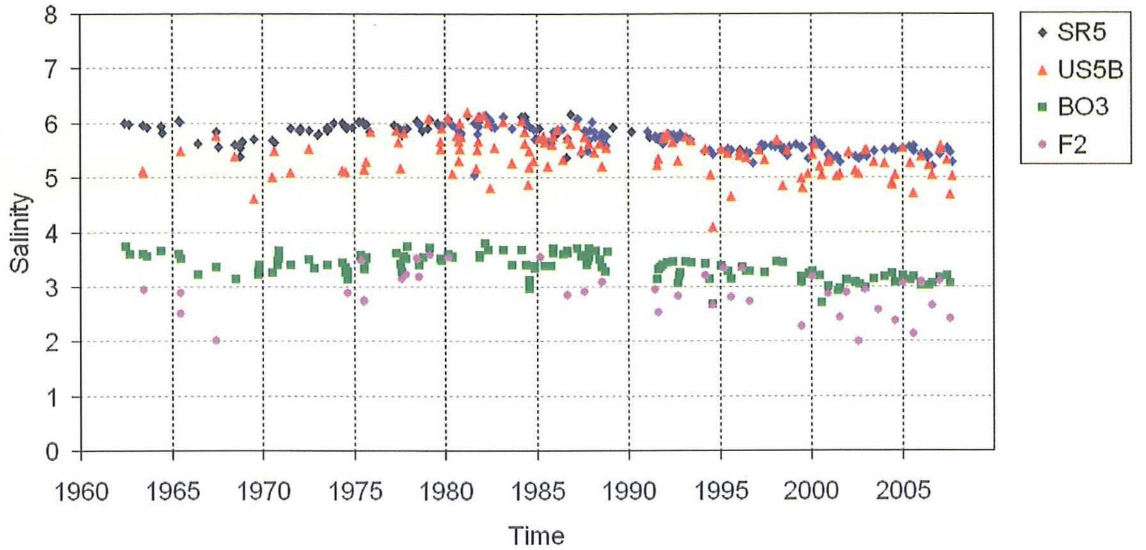


Fig. 4. Variation in surface salinity in the Bothnian Bay (BO3 and F2) and in the Bothnian Sea (SR5 and US5B).

Kuva 4. Pintasuolaisuuden vaihtelu Perämerellä (BO3 ja F2) ja Selkämerellä (SR5 ja US5B).

Bild 4. Variationen i ytvattnets salthalt i Bottenviken (BO3 och F2) och i Bottenhavet (SR5 och US5B).

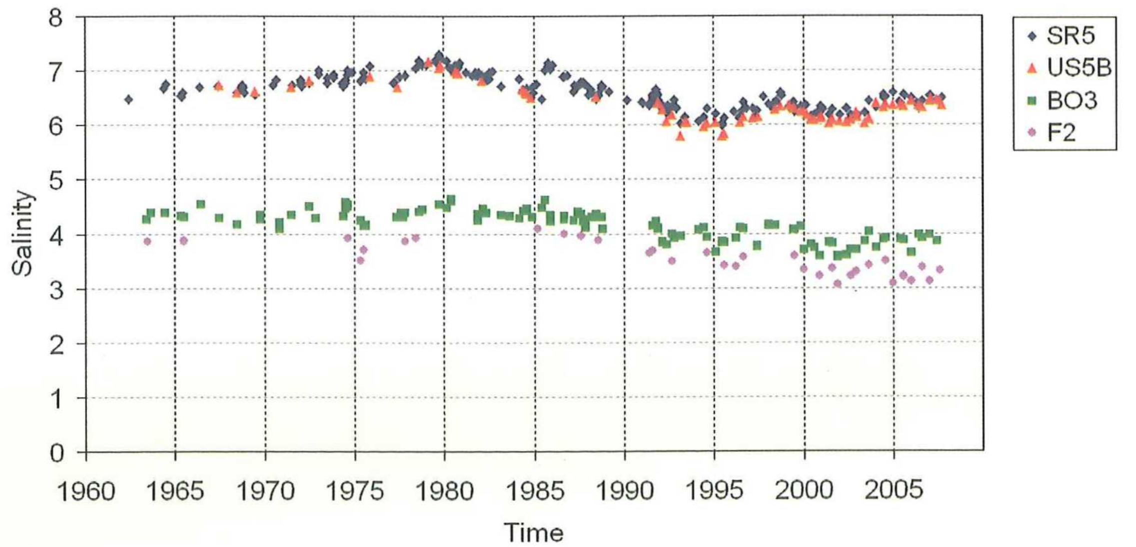


Fig. 5. Variation in deep-water salinity in the Bothnian Bay (BO3 and F2) and in the Bothnian Sea (SR5 and US5B).

Kuva 5. Syvän veden suolaisuuden vaihtelu Perämerellä (BO3 ja F2) ja Selkämerellä (SR5 ja US5B).

Bild 5. Salthaltsvariationerna i det bottennära vattnet i Bottenviken (BO3 och F2) och i Bottenhavet (SR5 och US5B).

The oxygen concentration in the near-bottom waters was generally between 4.5 and 6 ml/l. The level was relatively low for the area, as in the two previous years. In the deep northern Bothnian Sea the near-bottom oxygen concentration was the lowest ever measured, being round 3.8 ml/l; the oxygen saturation percent was also low, 46%.

Nutrient concentrations have been rather stable in the Gulf of Bothnia. Especially in the Bothnian Bay, the phosphate concentration is very low (<0.1 µmol/l) but it has increased a little during the last four years. However, this increase has no practical significance. The combined nitrate+nitrite concentration (5–9 µmol/l) has also increased very slowly during the last four years.

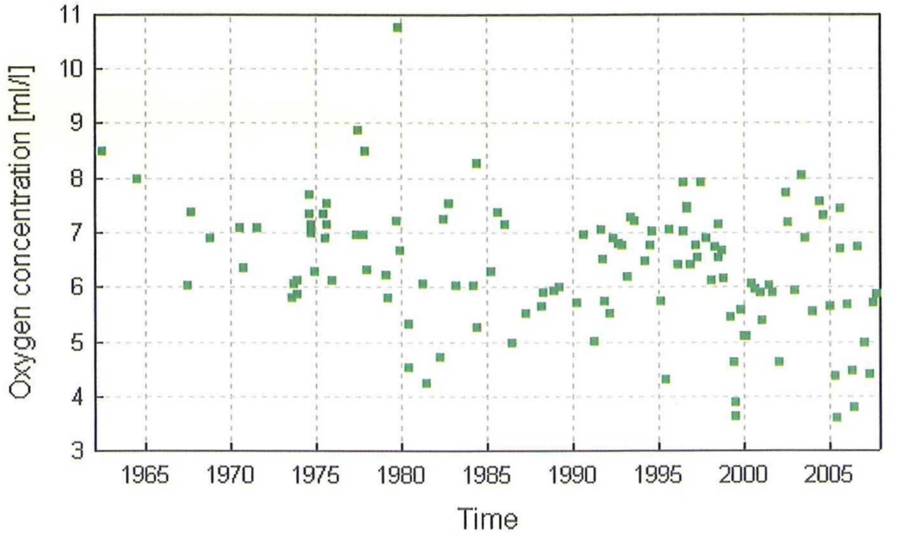


Fig. 6. Variation in near-bottom oxygen concentration in the southern Bothnian Sea (SR5).

Kuva 6. Pohjanläheisen veden happipitoisuuden vaihtelu eteläisellä Selkämerellä (SR5).

Bild 6. Syrehaltsvariationerna i det bottennära vattnet i södra Bottenhavet (SR5).

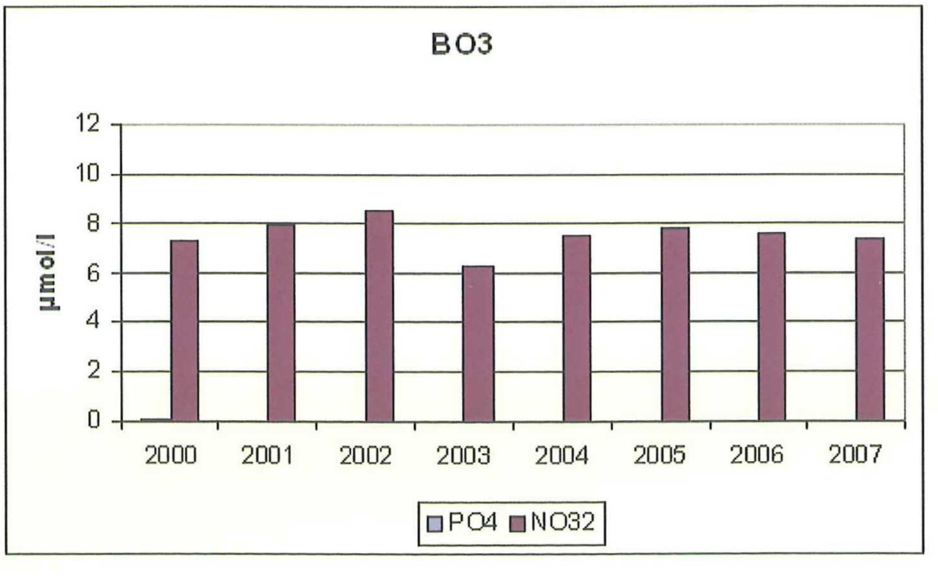


Fig. 7. Variation in nutrient concentrations in the Bothnian Bay in the 2000's.

Kuva 7. Ravinnepitoisuuksien vaihtelu Perämerellä 2000-luvulla.

Bild 7. Variationen i närsaltkoncentrationerna i Bottenviken under 2000-talet.

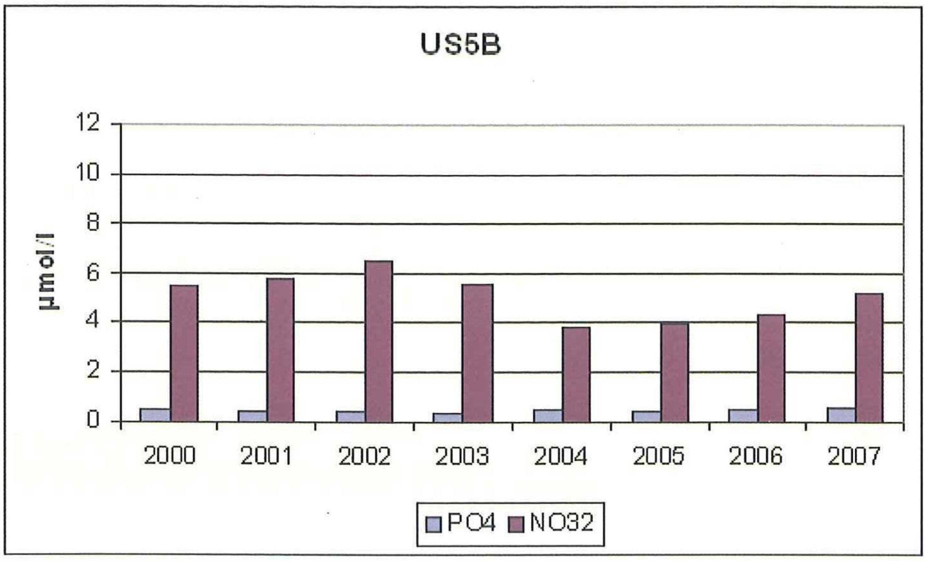


Fig. 8. Variation in nutrient concentrations in the northern Bothnian Sea in the 2000's.

Kuva 8. Ravinnepitoisuuksien vaihtelu pohjoisella Selkämerellä 2000-luvulla.

Bild 8. Variationen i närsaltkoncentrationerna i norra Bottenhavet under 2000-talet.

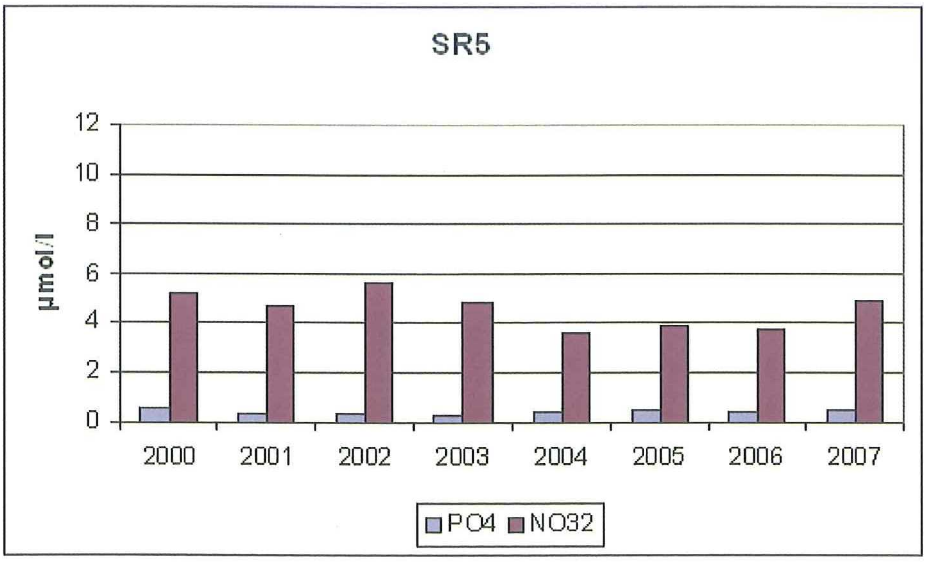


Fig. 9. Variation in nutrient concentrations in the southern Bothnian Sea in the 2000's.

Kuva 9. Ravinnepitoisuuksien vaihtelu eteläisellä Selkämerellä 2000-luvulla.

Bild 9. Variationen i närsaltkoncentrationerna i södra Bottenhavet under 2000-talet.

Åland Sea and Archipelago Sea

The sea surface temperature was exceptionally high in January (2–3°C in comparison to 0°C). By February the situation had returned to normal. Spring warming was normal till June, but in early June a short period occurred with warmer-than-average SST. There was then a cooler period in July, but by late August the SST was at its normal level again (around 19–20°C). The autumn cooling was average until the end of December.

The deep-water conditions in the Åland Sea were such that the temperatures were relatively high; salinity was around the same level as in the two-three previous years, except in January when the salinity was higher. The near-bottom oxygen concentration has followed a lowering trend since 1990's and in 2007 the concentrations near the bottom were the lowest ever.

The winter nutrient concentrations have also remained quite stable in the Åland Sea. In the Archipelago Sea the concentrations have increased slightly from the levels in the 1970's, but in 2007 the levels were on the same or even lower than in recent years.

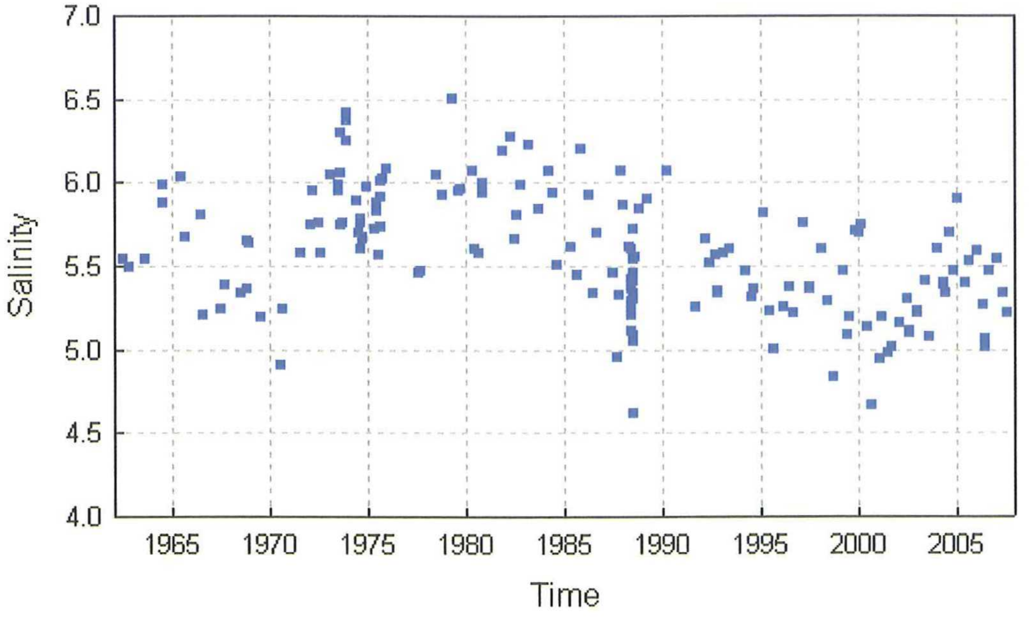


Fig. 10. Variation in surface salinity in the Åland Sea (F64).

Kuva 10. Pintaveden suolaisuuden vaihtelu Ahvenanmerellä (F64).

Bild 10. Variationen i ytvattnets salthalt i Ålands hav (F64).

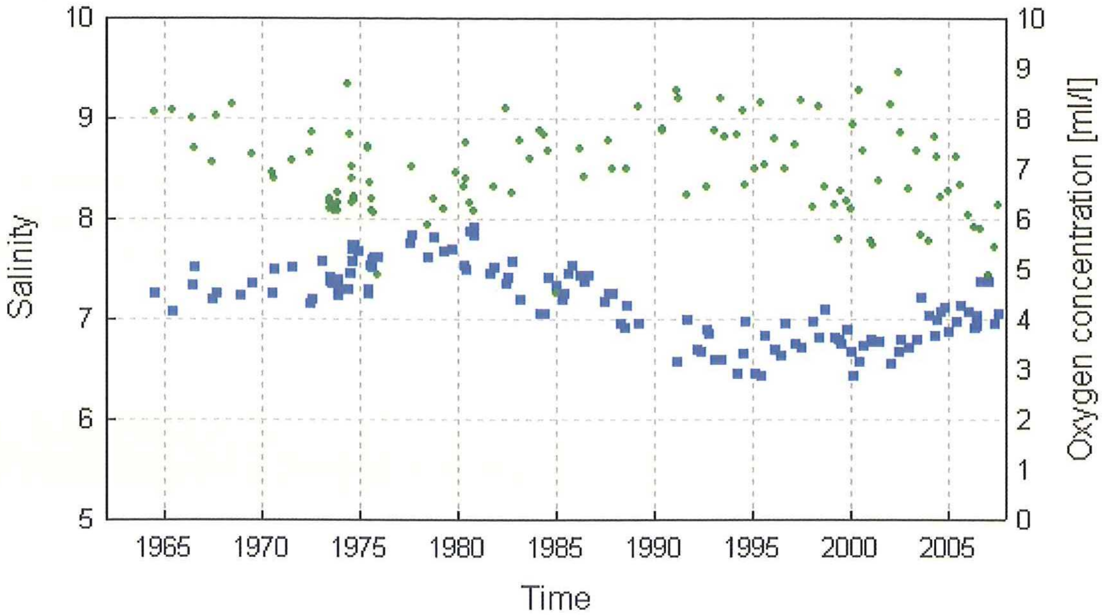


Fig. 11. Variation in deep-water (250 m) salinity and oxygen concentration in the Åland Sea (F64). Salinity is shown as blue dots (lower set of dots) and oxygen concentration as green dots (upper set of dots).

Kuva 11. Syvän veden (250 m) suolaisuuden ja happipitoisuuden vaihtelu Ahvenanmerellä (F64). Suolaisuus esitetään sinisinä pisteinä (alempi pistejoukko) ja happipitoisuus vihreinä pisteinä (ylempi pistejoukko).

Bild 11. Långtidsvariationen i salthalten (blåa punkter, nedre serien) och syrehalten (gröna punkter, övre serien) i det bottennära vattnet i Ålands hav (F64).

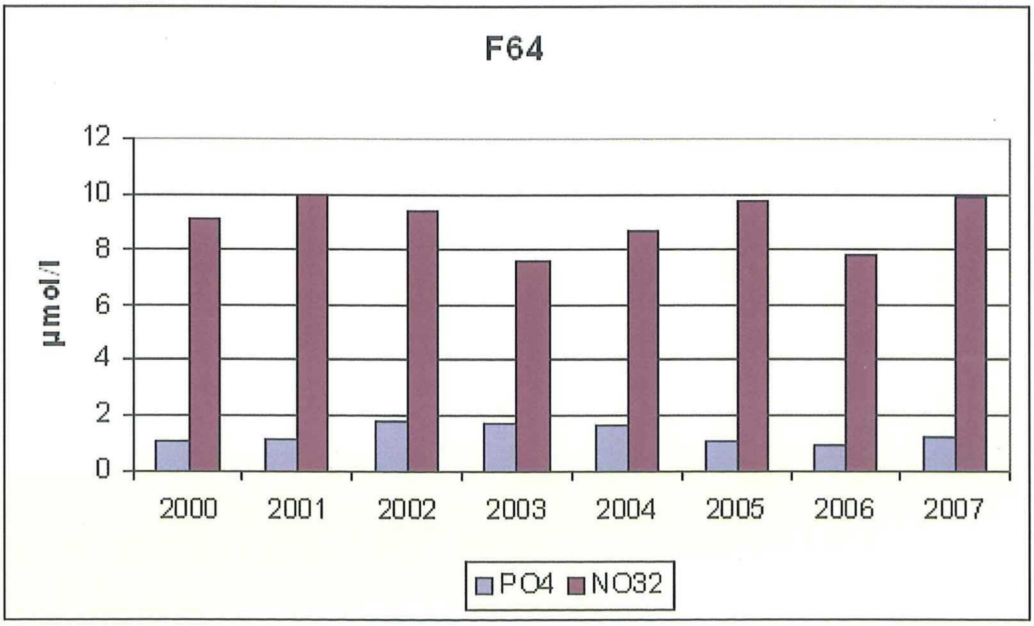


Fig. 12. Variation in nutrient concentrations in the Åland Sea (F64).

Kuva 12. Ravinnepitoisuuksien vaihtelu Ahvenanmerellä 2000-luvulla.

Bild 12. Variationen i närsaltkoncentrationerna i Ålands hav (F64) under 2000-talet.

Gulf of Finland

The sea surface temperature showed similar characteristics in the Gulf of Finland to those in the other sea areas. The year 2007 began with a warmer-than-average SST. The early spring was rather normal and in June the warming was stronger than average. This strong warming ended at the end of June, and July was slightly cooler than expected. The warmest period was the second half of August when the SST (around 19–20°C) was above average. The autumn was normal till December. The end of December was warmer than usual.

The deep-water temperatures were rather high in the Gulf of Finland. The deep-water salinity was rather similar to that in previous years. The deep-water masses moved back and forth, resulting in increased salinity in spring. A larger near-bottom salinity also usually leads to poorer oxygen conditions. This was also the case in 2007. At the beginning of the year the water was mixed down to depths of 70–80 m. The oxygen conditions were still good. During the spring a strong stratification formed in the deep layers, and the near-bottom oxygen concentration dropped to poor levels (< 2 ml/l). The late autumn mixing seems to have made the oxygen conditions a little better again in December.

The nutrient concentrations in the Gulf of Finland have remained at same level during the 2000's; in 2007 the phosphate concentration was around 1 µmol/l and the combined nitrate+nitrite concentration around 7–10 µmol/l. In 2006 the phosphate concentration was higher at LL7, but in 2007 it returned to the level of previous years.

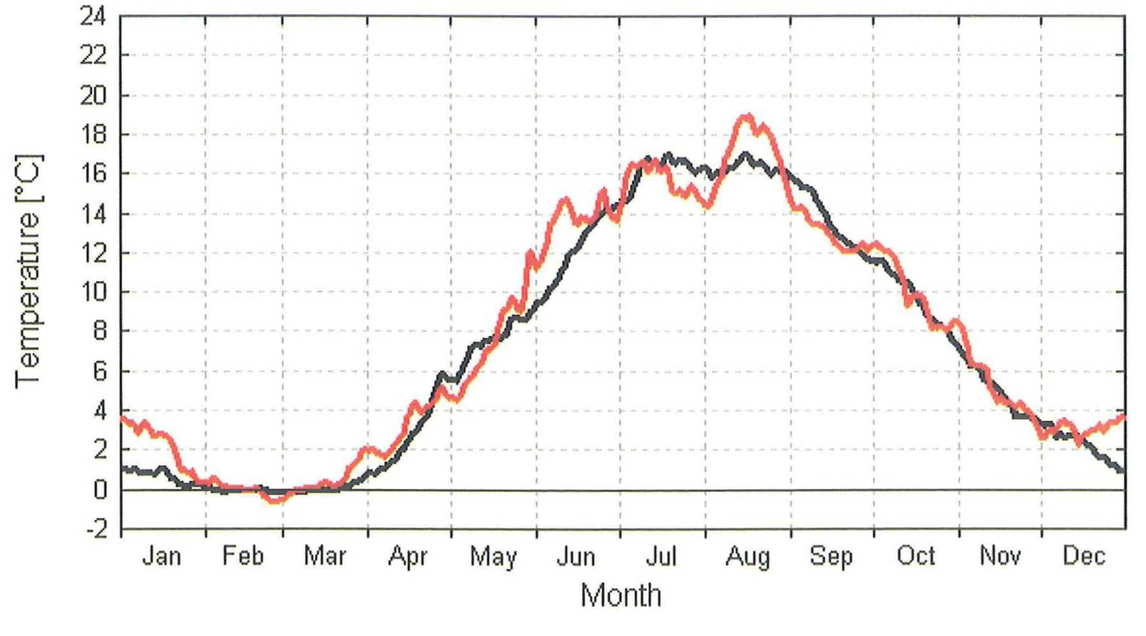
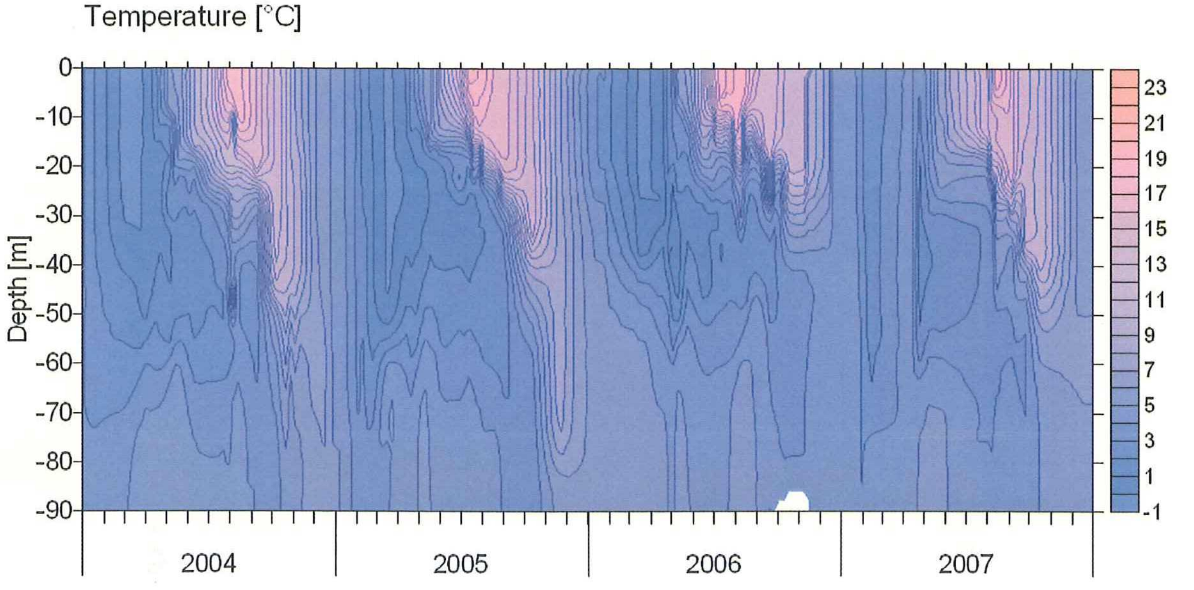


Fig. 13. Variation in near-surface temperature at the coast in the Gulf of Finland/Helsinki in 2007 (red, variable curve) in comparison to the average annual course in 1998-2006 (black, smoother curve).

Kuva 13. Rannikkoveden lämpötilan vaihtelu Suomenlahdella/Helsinki vuonna 2007 (punainen, vaihteleva käyrä) verrattuna keskimääräiseen vuotuiseen vaihteluun vuosina 1998-2006 (musta, tasaisempi käyrä).

Bild 13. Yttemperaturen vid Finska vikens kust (Helsingfors) år 2007 (den röda kurvan) jämfört med medelvärdet för 1998-2006 (den svarta kurvan).



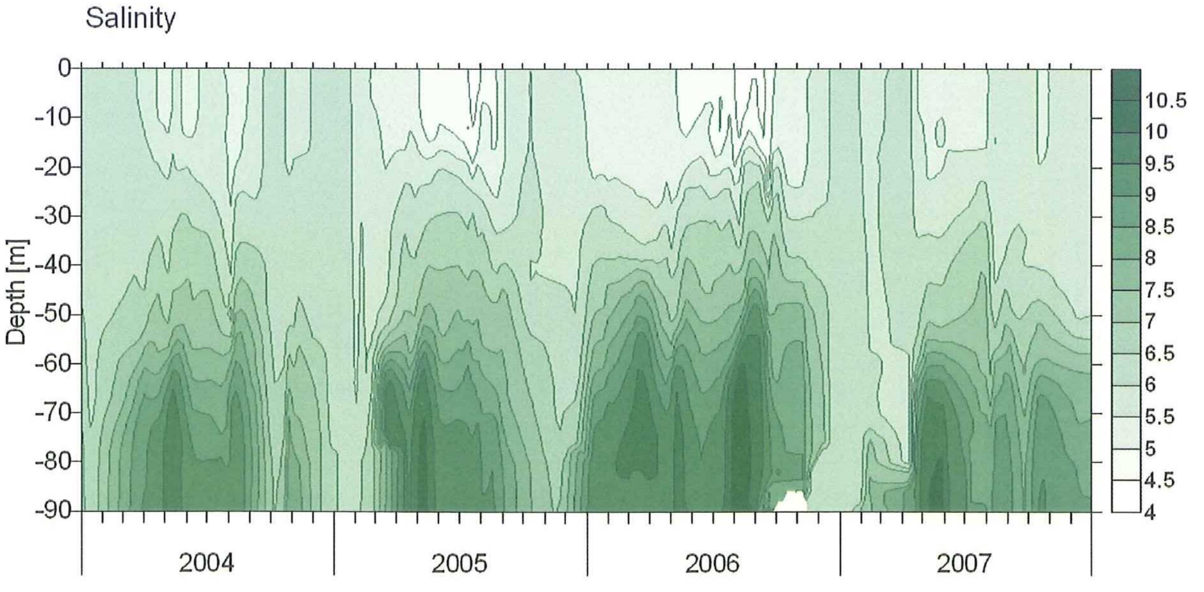


Fig. 14. Time variations of vertical temperature (upper panel) and salinity (lower panel) in the central Gulf of Finland (LL7) in 2004–2007 (graph Tuomo Roine).

Kuva 14. Pystysuora lämpötilan (ylempi kuva) ja suolaisuuden (alempi kuva) aikavaihtelu Suomenlahden keskiosassa (LL7) vuosina 2004–2007 (kuva Tuomo Roine).

Bild 14. Tuomo Roine. Den vertikala fördelningen av temperaturen (den övre bilden) och salthalten (den nedre bilden) i den centrala delen av Finska viken (LL7) 2004–2007 (bild Tuomo Roine).

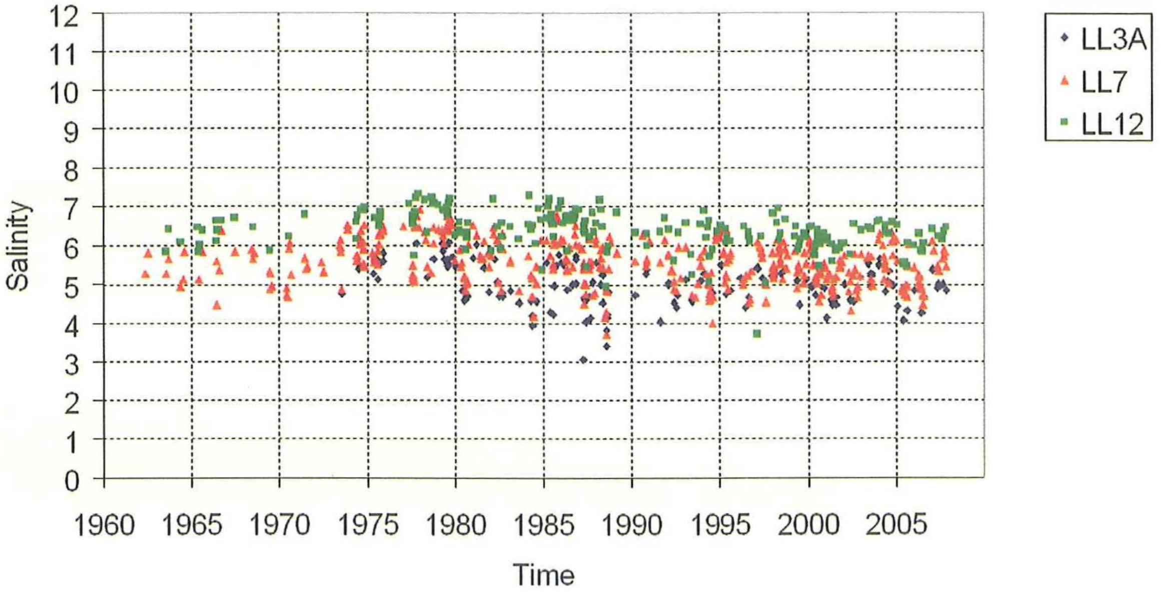


Fig. 15. Variation in surface salinity in the Gulf of Finland.

Kuva 15. Pintaveden suolaisuuden vaihtelu Suomenlahdella.

Bild 15. Bild 15. Variationen i ytvattentemperaturen i Finska viken.

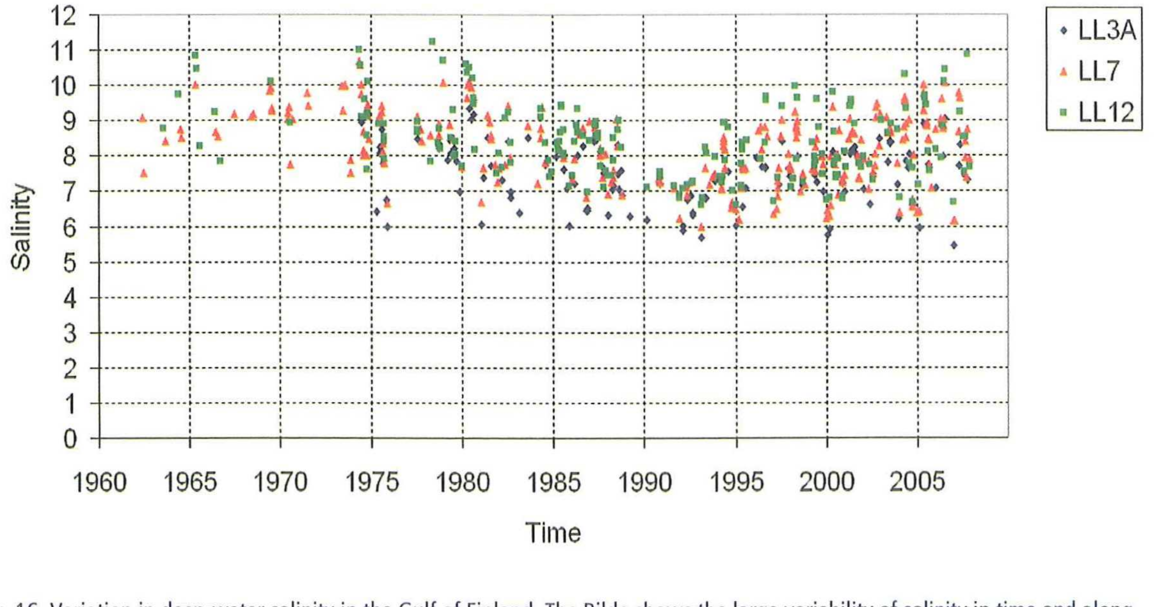


Fig. 16. Variation in deep-water salinity in the Gulf of Finland. The Bilde shows the large variability of salinity in time and along the gulf.

Kuva 16. Syvän veden suolaisuuden vaihtelu Suomenlahdella. Kuva osoittaa suolaisuuden suuren ajallisen ja lahdensuuntaisen vaihtelun.

Bild 16. Salthaltsvariationen i det bottennära vattnet i Finska viken.

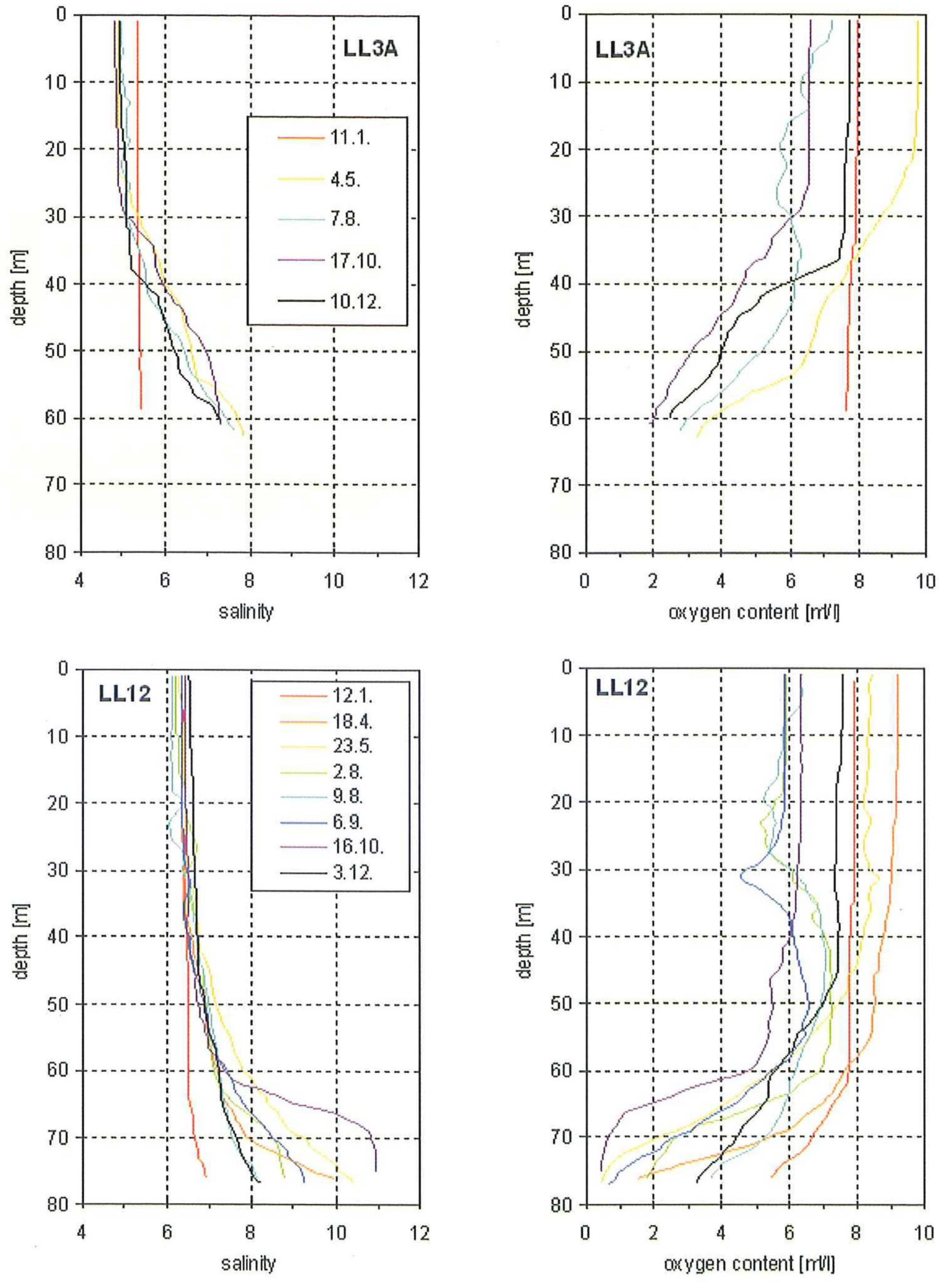


Fig. 17. Vertical profiles of salinity and oxygen in the Gulf of Finland during 2007.

Kuva 17. Suolaisuuden ja happipitoisuuden syvyysjakaumat Suomenlahdella vuonna 2007.

Bild 17. Utvecklingen av de vertikala salthalts- och syrehaltsprofilerna i Finska viken under år 2007.

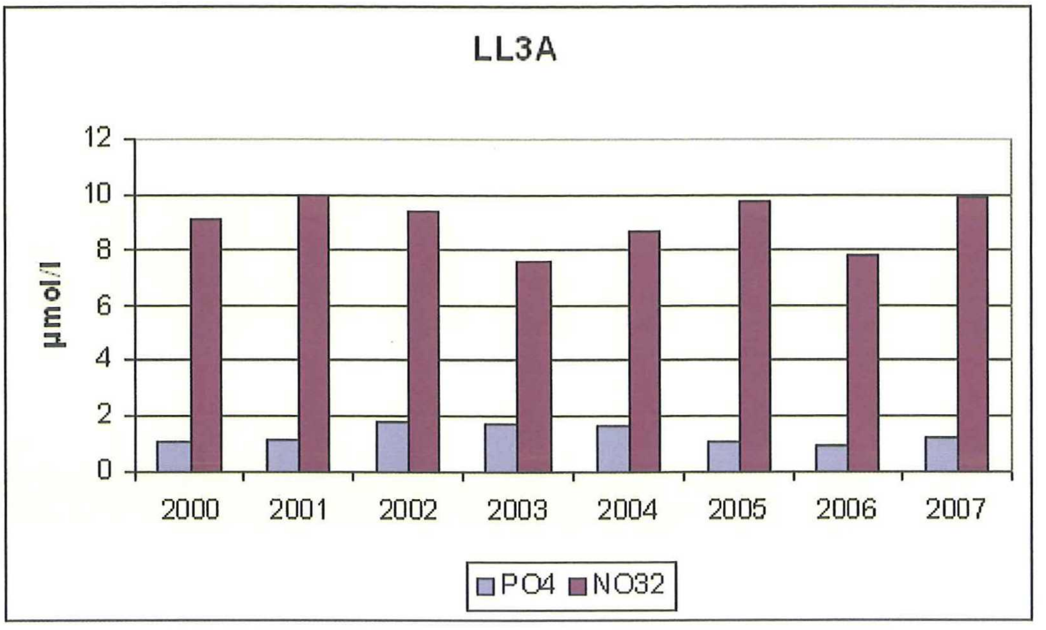


Fig. 18. Variation in nutrient concentrations in the eastern Finnish waters of the Gulf of Finland in the 2000's.

Kuva 18. Ravinnepitoisuuksien vaihtelu Suomen vesien itäosissa Suomenlahdella 2000-luvulla.

Bild 18. Variationen i närsaltkoncentrationerna i den östra delen av Finska viken under 2000-talet.

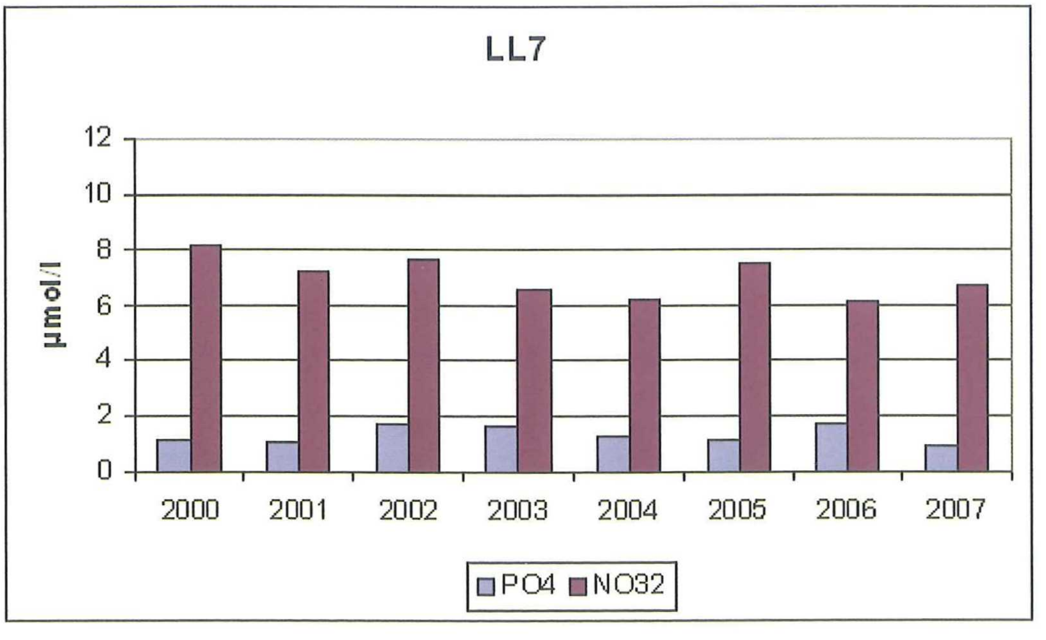


Fig. 19. Variation in nutrient concentrations in the central Gulf of Finland in the 2000's.

Kuva 19. Ravinnepitoisuuksien vaihtelu Suomenlahden keskiosissa 2000-luvulla.

Bild 19. Variationen i närsaltkoncentrationerna i den centrala delen av Finska viken under 2000-talet.

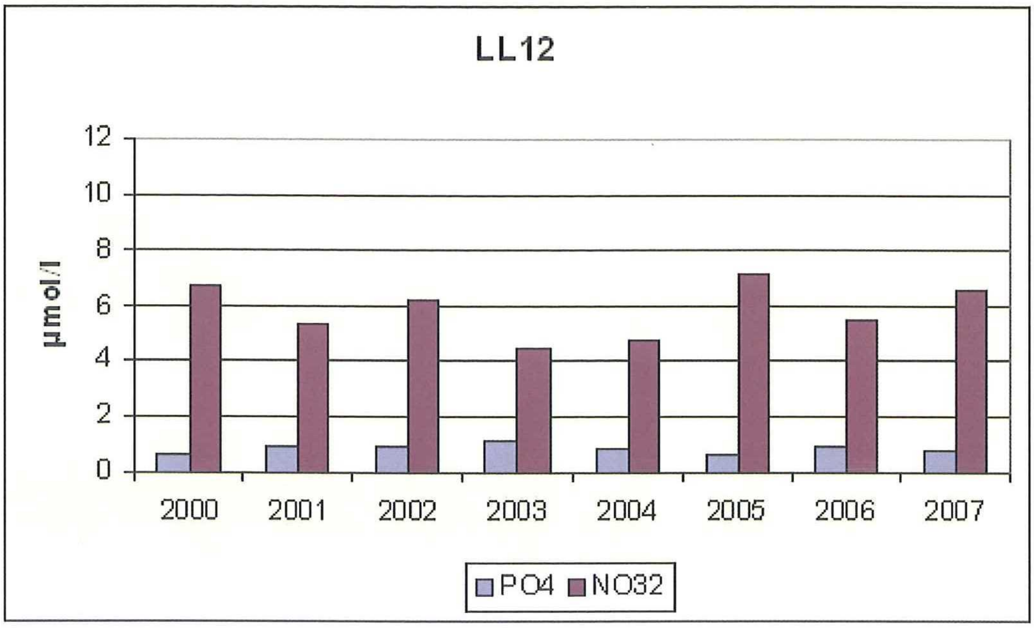


Fig. 20. Variation in nutrient concentrations in the western Gulf of Finland in the 2000's.

Kuva 20. Ravinnepitoisuuksien vaihtelu Suomenlahden länsiosissa 2000-luvulla.

Bild 20. Variationen i närsaltkoncentrationerna i den västra delen av Finska viken under 2000-talet.

The Northern Baltic Proper

The surface temperature variation in 2007 was similar to that in other sea areas. In January the surface temperature was higher than usual, and most probably the rest of the year was normal or slightly warmer than normal. The deep-water temperatures were also higher than normal, but this has already been the case for three-four years.

Surface salinity was normal, but deep-water salinity remained at the high level at which it has been in the last three years. This means that the stratification at the halocline has been strong. The halocline depth has been at around depths of 60–70 m.

Because of the strong stratification, there has been little oxygen in the deep waters. Below a depth of 70 m the oxygen content was very low and below 100 m there was no oxygen at all. Hydrogen sulphide was found in deep waters, as in 2006.

In 2007 the nutrient levels in the Northern Baltic Proper were at same level as they have been in the 2000's in general: phosphate at 2–3 µmol/l and combined nitrate+nitrite also at levels around 2–3 µmol/l.

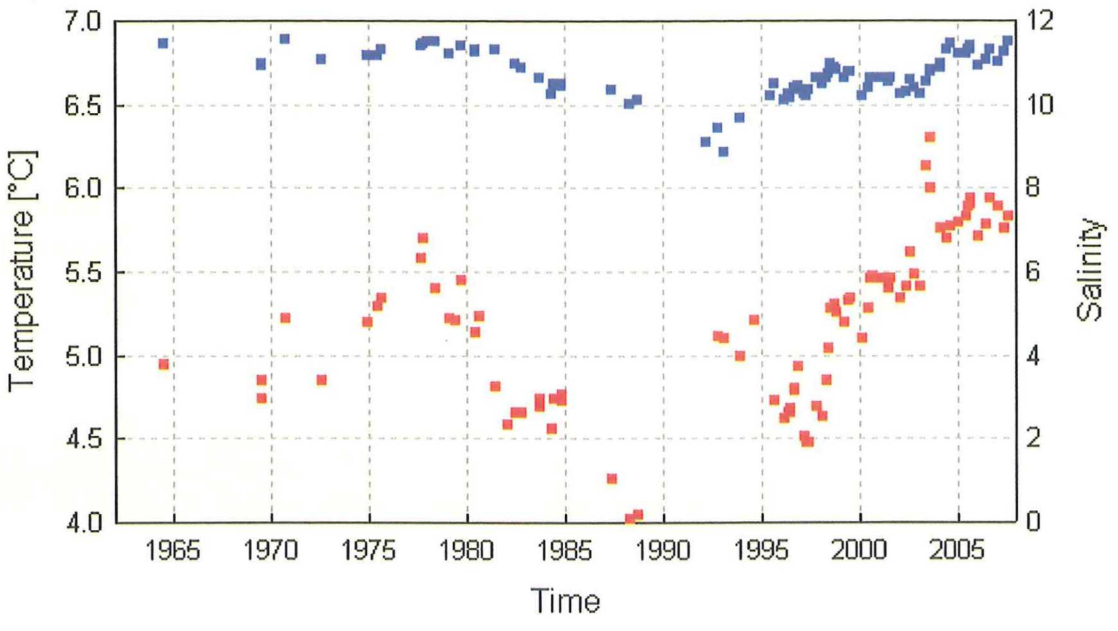


Fig. 21. Variation in near-bottom temperature (red, lower dot set) and salinity (blue, upper dot set) in the Northern Baltic Proper (LL17).

Kuva 21. Pohjanläheinen lämpötilan (punainen, alempi pistejoukko) ja suolaisuuden (sininen, ylempi pistejoukko) vaihtelu Varsinaisen Itämeren pohjoisosassa (LL17).

Bild 21. Långtidsvariationen i salthalten (blåa punkter, övre serien) och syrehalten (röda punkter, nedre serien) i norra Egentliga Östersjön (LL17).

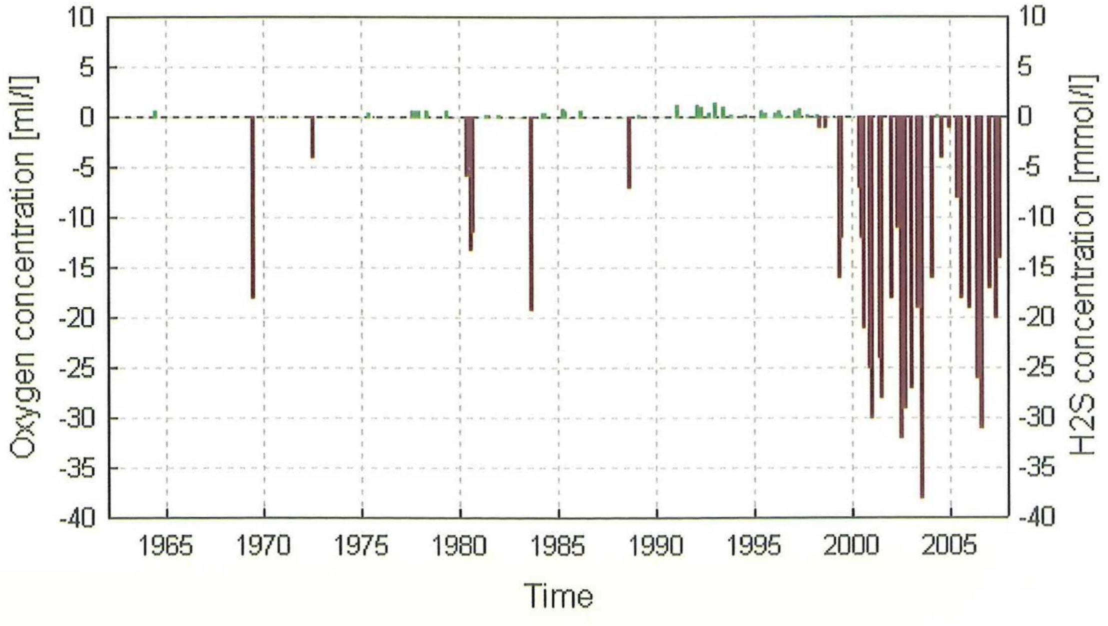


Fig. 22. Long-term variability between oxic and anoxic conditions in the near-bottom water of the Northern Baltic Proper. Oxygen concentration is shown in green as positive values; hydrogen sulphide in red as negative values.

Kuva 22. Hapellisten ja hapettomien tilanteiden pitkäaikaisvaihtelu Varsinaisen Itämeren pohjoisosan merenpohjan tuntumassa. Happipitoisuus on kuvattu vihreillä, ylöspäin osoittavilla pylväillä ja rikkivety punaisilla alaspäin osoittavilla pylväillä.

Bild 22. Växlingarna mellan perioder med syre och syrefria perioder mes svavelväte i det bottennära vattnet i norra Egentliga Östersjön. Syrehalten anges i gröna positiva värden och svavelväte som röda negativa värden.

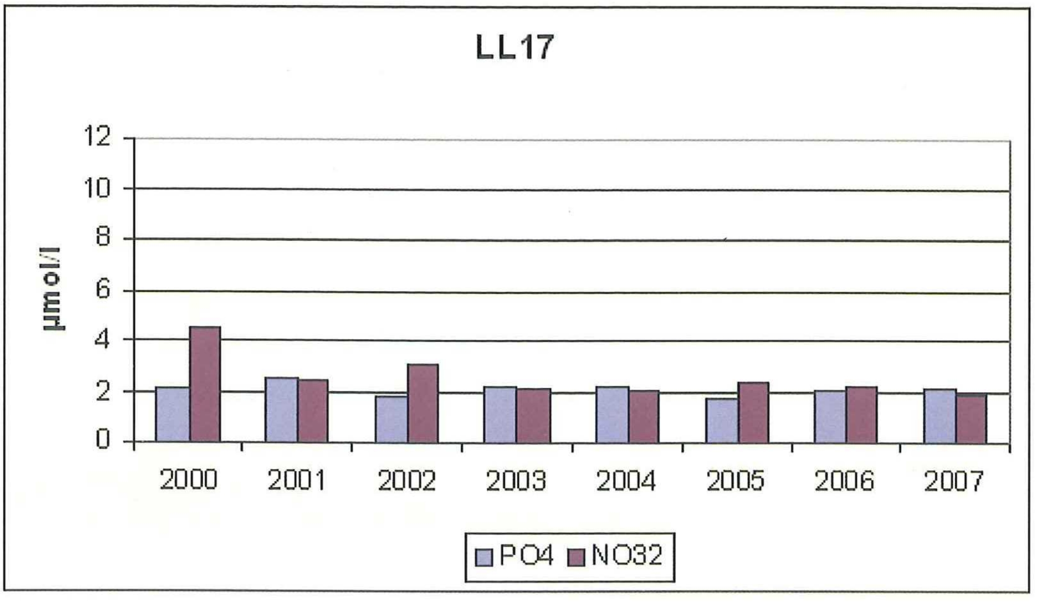


Fig. 23. Variation in nutrient concentrations in the Northern Baltic Proper (LL17) in the 2000's.

Kuva 23. Ravinnepitoisuuksien vaihtelu Varsinaisen Itämeren pohjoisosassa 2000-luvulla.

Bild 23. Variationen i närsaltkoncentrationerna i den norra delen av Egentliga Östersjön under 2000-talet.

Gotland Deep

The Gotland Deep is one of the most studied places in the Baltic Sea, being the major deep in the Baltic Sea Proper and one of the deepest areas in the Baltic Sea. It tells the story of the state of the deep waters of the Baltic Sea. Salinity pulses are considered significant when they reach the Gotland Deep.

The Southern Baltic Proper

The temperature variations at the surface in 2007 followed the same behaviour as in other sea areas in the Baltic Sea. Thus the early part of 2007 was warmer than average, there was a cooler season in June and then August and the autumn were slightly warmer than average.

The salinity profile was similar to that in the Northern Baltic Proper; the surface salinity was thus rather normal, but the deep-water salinity was at a relatively high level.

The oxygen situation in the deep waters below the halocline in the Southern Baltic Proper was poor.

Nutrient concentrations in the Southern Baltic Proper have increased from the levels of the 1970's. In the 2000's the levels have been variable but without clear trends.

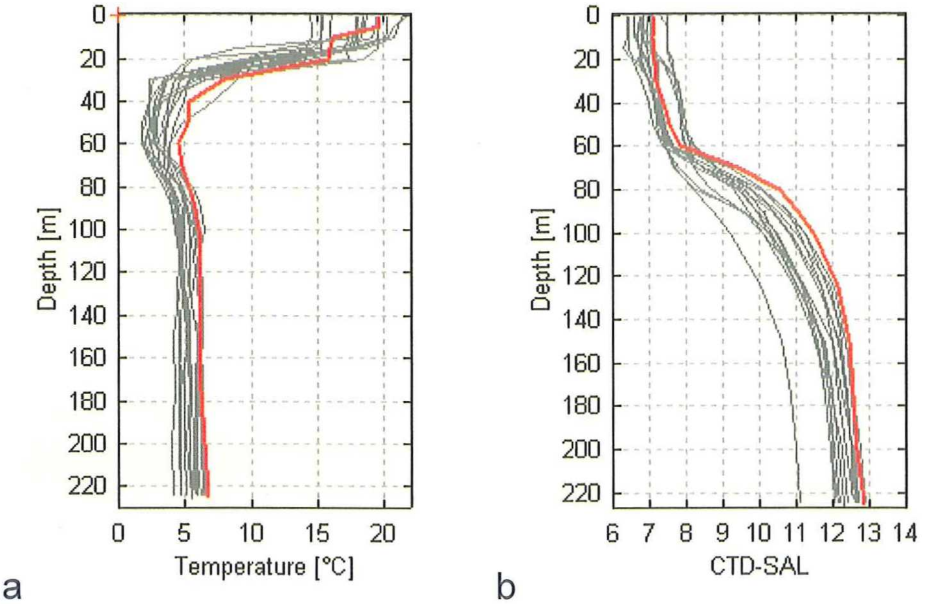


Fig. 24. Temperature (a) and salinity (b) profiles in the Gotland Deep. All the profiles are from August. The grey lines from years 1980–2006 and the red lines from August 2007.

Kuva 24. Lämpötilan (a) ja suolaisuuden (b) syvyyssuuntaiset jakaumat Gotlannin syvänteessä. Elokuiset profiilit vuosilta 1980–2006 on piirretty harmaalla ja elokuussa 2007 mitatut profiilit punaisella.

Bild 24. Vertikala salthalts- och syrehalts-profiler i Gotlandsdjupet. De röda profilerna visar situationen i augusti 2007, de gråa profilerna i augusti 1980–2006.

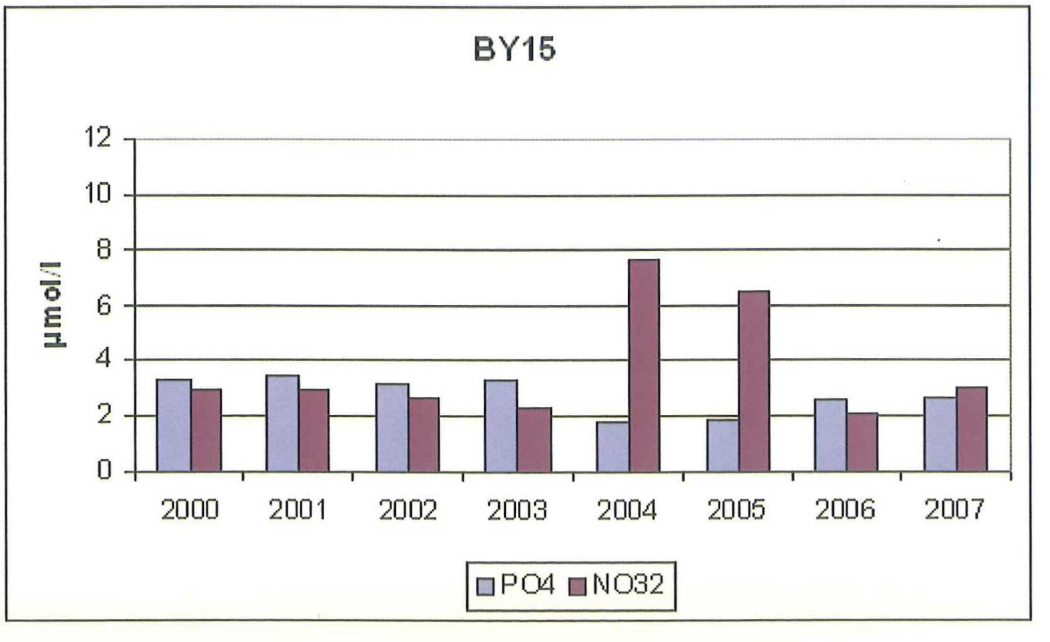


Fig. 25. Variation in nutrient concentrations in the Gotland Deep in 2000's.

Kuva 25. Ravinnepitoisuuksien vaihtelu Gotlannin syvänteessä 2000-luvulla.

Bild 25. Variationen i närsaltkoncentrationerna i Gotlandsdjupet under 2000-talet.

5. TRENDS IN SOFT SEDIMENT MACROZOOBENTHIC COMMUNITIES IN THE OPEN SEA AREAS OF THE BALTIC SEA

Alf Norkko & Marko Jaale

Introduction

Soft-sediment macrobenthic communities provide important ecosystem services and are central elements of Baltic Sea ecosystems. Most macrobenthic animals are relatively long-lived (several years) and thus integrate changes and fluctuations in the environment over a longer period of time. Thus variations in species composition, abundance and biomass can be used to assess environmental conditions and disturbance events. In the brackish Baltic Sea the distribution and abundance of species is governed by the distinctive salinity and oxygen gradients present. These conditions result in strong gradients in species and functional diversity throughout the Baltic Sea.

In the Baltic basins, widespread oxygen deficiency is caused by the restricted water exchange of the deep water due to the permanent halocline at depths of 60 to 80 m. The deep water can only be renewed by irregular intrusions of saline water through the Danish straits and the extent and severity of oxygen deficiency in the subhalocline area depend on the frequency of major inflows and the length of the stagnation periods. During long stagnation periods, without major inflows, density stratification is reduced and the halocline shifted deeper. Major inflows transport oxygen-rich water even to the deepest areas but, unless they are frequent, cause only short-term improvement in the deep-water oxygen conditions. However, the inflows also tend to strengthen stratification, which then, again, promotes the development of hypoxia and anoxia. This is where the effects of anthropogenic eutrophication come into play, i.e., by increasing oxygen demand and exacerbating the conditions in those Baltic basins already prone to oxygen deficiency.

At the FIMR, regular monitoring of macrozoobenthos in the open sea areas was initiated in 1965. Sampling is conducted annually in May–June and in principle covers all regions of the Baltic Sea except for the Gulf of Riga and the western Gotland Basin. The sampling and analyses have been carried out according to the guidelines for the HELCOM-COMBINE programme, where they are described in detail.

Säännöllinen avomeren pohjaeläinyhteisöjen tarkkailu aloitettiin Merentutkimuslaitoksella jo vuonna 1965. Pohjaeläinnäytteitä otetaan vuosittain touko–kesäkuussa lähes koko Itämeren alueelta, lukuunottamatta Riianlahtea ja läntistä Gotlannin allasta. Näytteenotossa ja analyyseissä noudatetaan HELCOM-COMBINE -ohjeistusta.

Övervakningen av bottenfauna i öppna havsområden påbörjades vid Havsforskningsinstitutet år 1965. Provtagningar utförs årligen i maj–juni och omfattar så gott som hela östersjön, förutom Riga bukten och den västra Gotländska bassängen. Provtagningar och analyser följer rekommendationerna uppställda av HELCOM-COMBINE programmet.

Thus the deeper water benthic communities, below the halocline, are comparatively less diverse than their shallow water counterparts, and are naturally exposed to hypoxic disturbance events depending on the frequency and intensity of the episodic saltwater intrusions. Without question, eutrophication has exacerbated the intensity of naturally-occurring hypoxic events. Long-term monitoring and knowledge of the natural fluctuations in the environment are critical for understanding the dynamics of the system and interpreting possible anthropogenic changes. In this regard, monitoring of macrozoobenthos provides some of the best available biological long-term information on changes in the Baltic Sea.

Gulf of Bothnia

In the Gulf of Bothnia, low salinity prevents the formation of water column stratification and oxygen deficiency, and also strongly reduces faunal diversity. Historically macrobenthic communities have been entirely dominated by the amphipod *Monoporeia affinis*, which exhibits strong natural fluctuations in population abundance and usually comprises 70–100% of total community abundance. Abundances have been severely reduced since their peaks in the early to mid-1990's (Fig. 1) and are generally below the long-time average. The reasons for this decline are unknown. However, some recovery has been observed in the Bay of Bothnia. The invasive polychaete *Marenzelleria* sp has spread rapidly throughout most of the Gulf. In the southern Bothnian Sea (station SR5), abundances increased noticeably between 2004 and 2006 (when they comprised about 80% of total community abundance), but now polychaete numbers appear to be declining and those of the amphipods *Monoporeia* and *Pontoporeia* recovering (Fig. 1).

Gulf of Finland

In the Gulf of Finland the salinity stratification disappeared during the prolonged stagnation and lack of saltwater inflows during 1977–1993, but was re-established in 1993–94. The abundant macrobenthic communities recorded in the early 1990s in the deep central parts of the Gulf crashed almost completely in 1996–97, and have not recovered to any larger extent, due to continued poor oxygen conditions below the permanent halocline (Fig. 2). Key benthic species for this area include the clam *Macoma balthica*, the amphipods *Monopereia* and *Pontoporeia*, the large isopod *Saduria entomon*, and the polychaete *Bylgides* (*Harmothoe*) *sarsi*. This polychaete is often the first to colonise after the termination of hypoxic events and is consequently often found in low abundances during temporarily improved oxygen conditions.

The Northern Baltic Proper

In the Northern Baltic Proper the macrobenthic communities below the permanent halocline have either totally disappeared or become utterly impoverished as a result of the oxygen deficiency caused by the saltwater inflow and subsequent strengthening of the halocline in 1993–1994 (Fig. 3). At present the area devoid of macrofauna is of the same size as during the middle of the last stagnation period in the 1970s and 1980s, i.e., about one-third of the total sea area (Fig. 4). The latest larger saltwater inflow in 2003 resulted in some colonization by opportunistic species in the Gotland Basin area, but oxygen conditions have since deteriorated, and in 2005 conditions were once again anoxic and macrofauna more or less eliminated. Conditions are below the all-time average and in a very poor state. At LL17 in the Northern Baltic Proper, the only species that occurs occasionally is the opportunistic *Bylgides* (*Harmothoe*).

The Southern Baltic Sea

In the Southern Baltic Sea, and in the Arkona and Bornholm Basins, species diversity is much higher than in the other Baltic basins due to higher salinity. However, also this area is also subjected to periodic hypoxic events, and, except for BY2 in the Bornholm Basin, conditions are currently very severe and well below the long-term average. Following the largest observed saltwater inflow of the 20th century, which occurred in the 1950's, also the southern Baltic has exhibited an overall reduction in salinity. This has resulted in a gradual replacement of more marine species by typical brackish water species (Fig. 5).

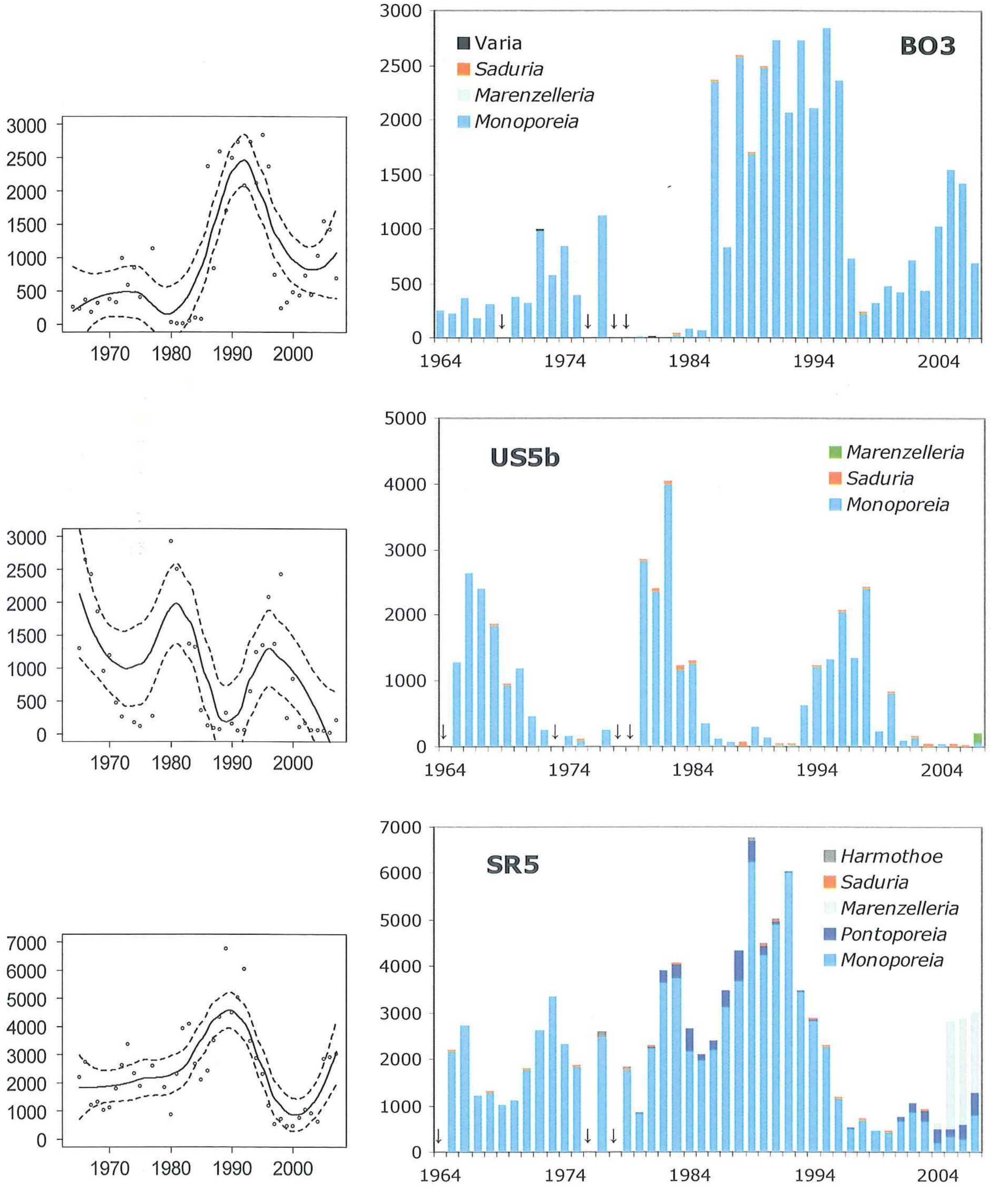


Fig. 1. Gulf of Bothnia. Trends in macrozoobenthic community abundance (LOESS smoothing) and composition. The x-axes depict years and the y-axes the number of individuals per m^2. Note the differences in scale of the y-axes. Arrows indicate years when stations have not been sampled. For station locations: see Chapter 4 (Fig. 1).

Kuva 1. Pohjanlahti. Makroskooppisen pohjaeläimistön yksilömäärien kehitys (LOESS-silotus) ja koostumus. X-akselilla on näytteenottovuodet ja nuolet kuvaavat puuttuvia näytteenottoja, y-akselilla on yksilömäärät neliömetrillä. Huomaa asteikkoerot y-akselilla. Asemien sijainti: katso luku 4 (kuva 1).

Bild 1. Bottniska viken. Långtidsförändringar i bottendjurssamhällen (LOESS approximering). X-axeln anger år och y-axeln täthet per kvadratmeter. Notera skillnaderna i skala på y-axeln. Pilarna anger år då provtagning inte genomförts. Provtagningsstationernas positioner finns angivna i kapitel 4 (bild 1).

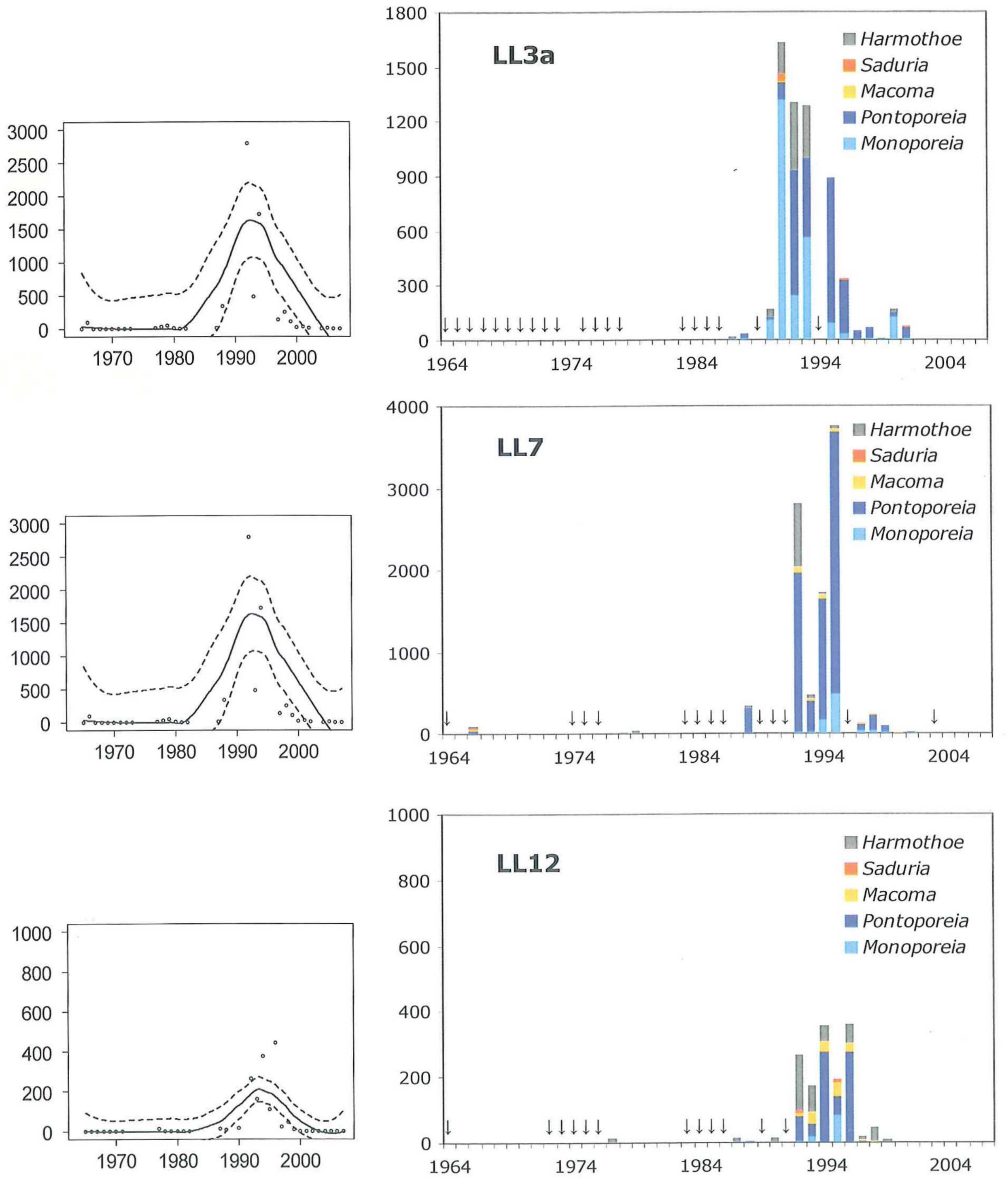
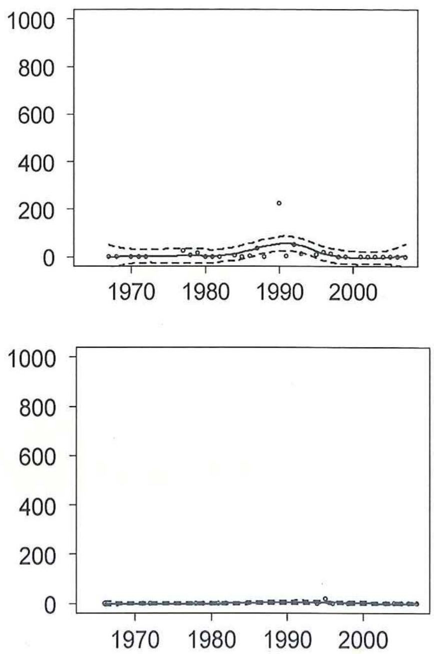


Fig. 2. Gulf of Finland. Trends in macrozoobenthic community abundance (LOESS smoothing) and composition. The x-axes depict years and the y-axes the number of individuals per m^2. Note the differences in scale of the y-axes. Arrows indicate years when stations have not been sampled. For station locations: see Chapter 4 (Fig. 1).

Kuva 2. Suomenlahti. Makroskooppisen pohjaeläimistön yksilömäärien kehitys (LOESS-silotus) ja koostumus. X-akselilla on näytteenottovuodet ja nuolet kuvaavat puuttuvia näytteenottoja, y-akselilla on yksilömäärät neliömetrillä. Huomaa asteikkoerot y-akselilla. Asemien sijainti: katso luku 4 (kuva 1).

Bild 2. Finska viken. Långtidsförändringar i bottendjurssamhällen (LOESS approximering). X-axeln anger år och y-axeln täthet per kvadratmeter. Notera skillnaderna i skala på y-axeln. Pilarna anger år då provtagning inte genomförts. Provtagningsstationernas positioner finns angivna i kapitel 4 (bild 1).



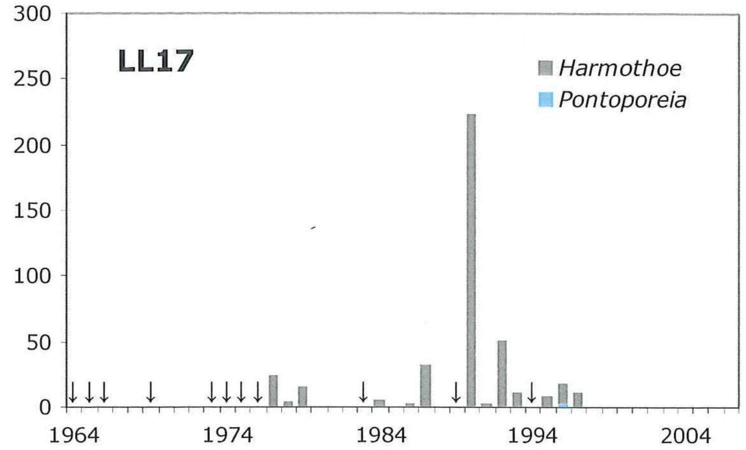


Fig. 3. The Northern Baltic Proper. Trends in macrozoobenthic community abundance (LOESS smoothing) and composition. The x-axes depict years and the y-axes the number of individuals per m^2. Note the differences in scale of the y-axes. Arrows indicate years when stations have not been sampled. For station locations: see Chapter 4 (Fig. 1).

Kuva 3. Pohjoinen varsinainen Itämeri. Makroskooppisen pohjaeläimistön yksilömäärien kehitys (LOESS-silotus) ja koostumus. X-akselilla on näytteenottovuodet ja nuolet kuvaavat puuttuvia näytteenottoja, y-akselilla on yksilömäärät neliömetrillä. Huomaa asteikkoerot y-akselilla. Asemien sijainti: katso luku 4 (kuva 1).

Bild 3. Norra egentliga Östersjön. Långtidsförändringar i bottendjurssamhällen (LOESS approximering). X-axeln anger år och y-axeln täthet per kvadratmeter. Notera skillnaderna i skala på y-axeln. Pilarna anger år då provtagning inte genomförts. Provtagningsstationernas positioner finns angivna i kapitel 4 (bild 1).

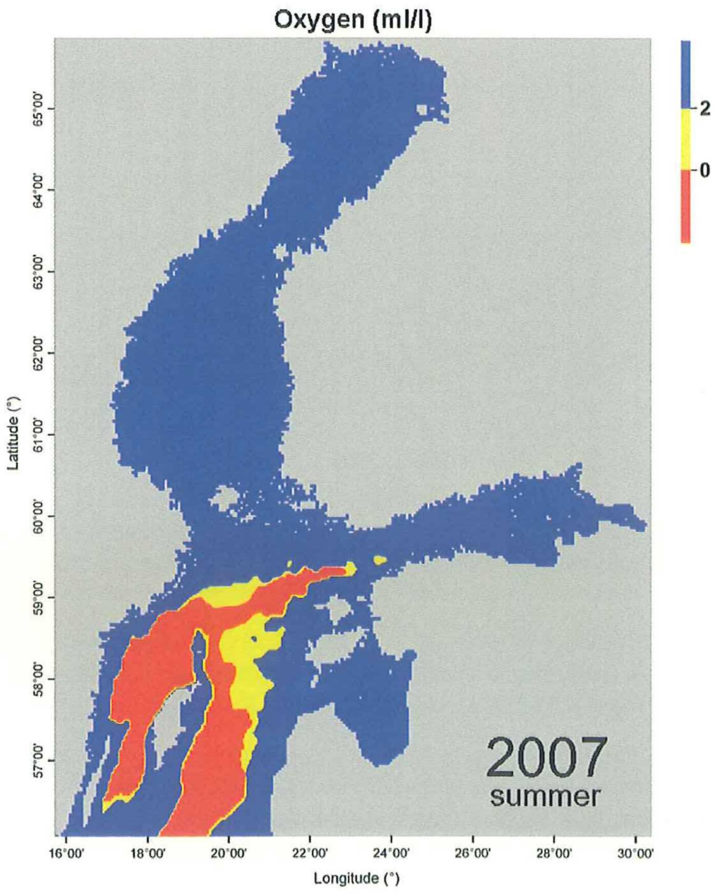


Fig. 4. The spatial extent of hypoxic (<2ml/l O_2, indicated by yellow) and anoxic (O_2=0 ml/l, indicated by red) deep water in the Northern Baltic Proper and in the Gulf of Finland.

Kuva 4. Pohjanläheisen veden vähähappisuus (<2ml/l O_2, keltaisella) ja hapettomuus (O_2= 0 ml/l, punaisella) pohjoisella varsinaisella Itämerellä ja Suomenlahdella.

Bild 4. Utbredningen av syrefattigt (<2ml/l O_2, indikerat med gult) och syrefritt (O_2=0 ml/l, indikerat med rött) bottenvatten i norra Egentliga Östersjön och Finska Viken.

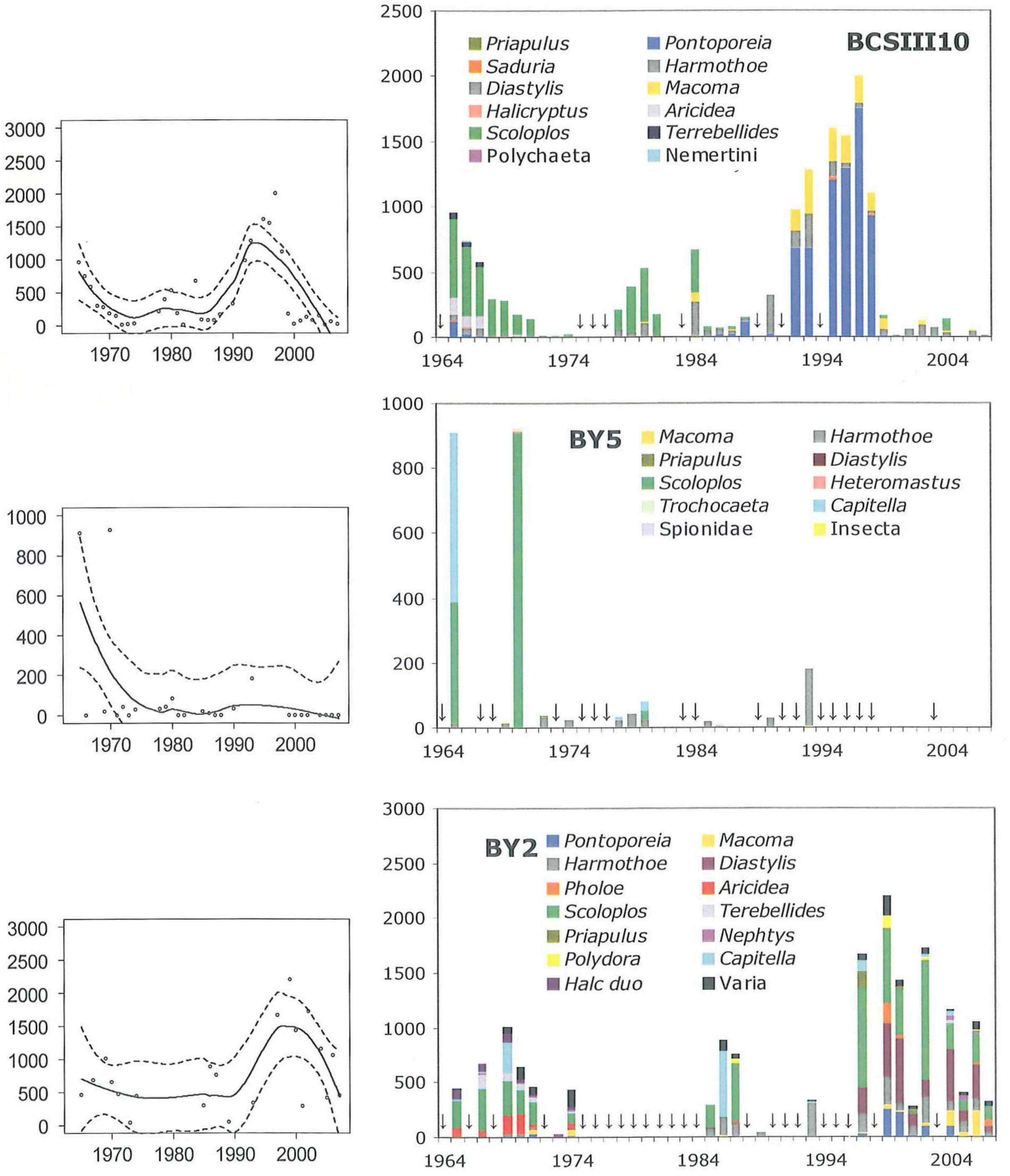


Fig. 5. The southern Baltic Sea. Trends in macrozoobenthic community abundance (LOESS smoothing) and composition. The x-axes depict years and the y-axes the number of individuals per m^2. Note the differences in scale of the y-axes. Arrows indicate years when stations have not been sampled. For station locations: see Chapter 4 (Fig. 1).

Kuva 5. Eteläinen varsinainen Itämeri. Makroskooppisen pohjaeläimistön yksilömäärien kehitys (LOESS-silotus) ja koostumus. X-akselilla on näytteenottovuodet ja nuolet kuvaavat puuttuvia näytteenottoja, y-akselilla on yksilömäärät neliömetrillä. Huomaa asteikkoerot y-akselilla. Asemien sijainti: katso luku 4 (kuva 1).

Bild 5. Södra Östersjön. Långtidsförändringar i bottendjurssamhällen (LOESS approximering). X-axeln anger år och y-axeln täthet per kvadratmeter. Notera skillnaderna i skala på y-axeln. Pilarna anger år då provtagning inte genomförts. Provtagningsstationernas positioner finns angivna i kapitel 4 (bild 1).

Conclusions

- Macrobenthic communities are severely degraded throughout the Baltic Proper and the Gulf of Finland, and are below the long-term average. Populations of the amphipod *Monoporeia affinis* have crashed in the Gulf of Bothnia, although some initial recovery is indicated, and the invasive polychaete *Marenzelleria* sp has spread.
- Biodiversity and ecosystem function are inextricably linked; the few macrobenthic species that have adapted to the low salinity conditions in the Baltic Sea play an exceedingly important role. This low functional diversity makes the ecosystem vulnerable to additional disturbances.
- The difficulty in defining historic reference conditions emphasizes the importance of conducting continuous long-term monitoring over large spatial scales for assessing changes.

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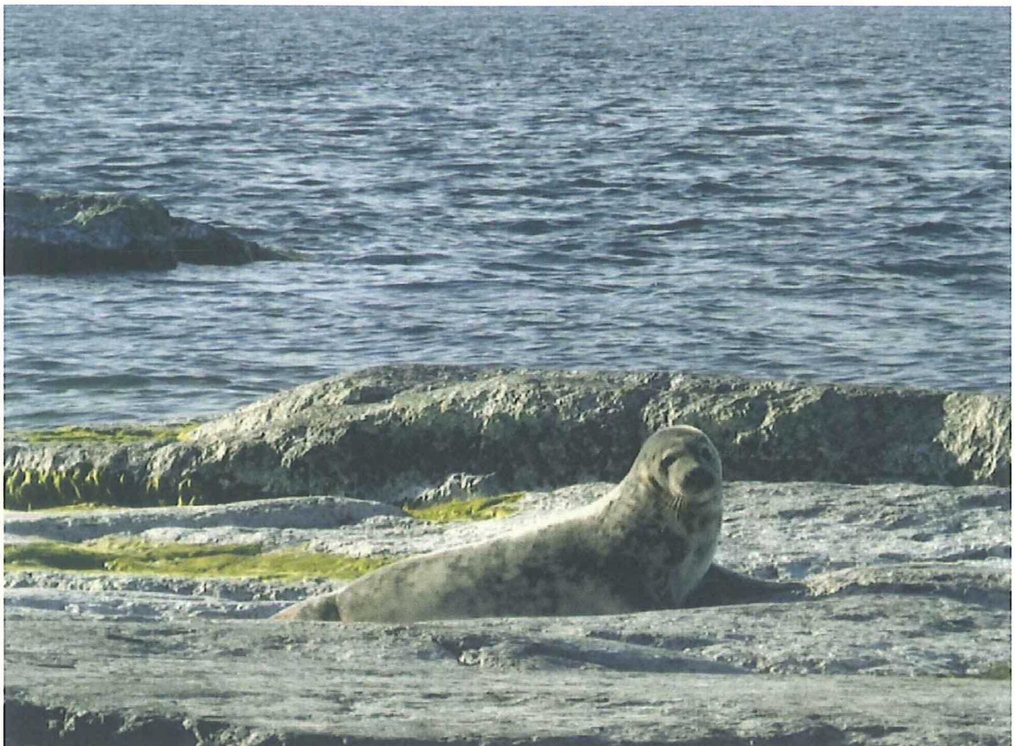


6. PHYTOPLANKTON AND CHLOROPHYLL-*a*

Seppo Kaitala, Hermanni Kaartokallio, Vivi Fleming-Lehtinen & Maija Huttunen

Development of chlorophyll-*a* during 2007

The annual development of chlorophyll-*a* during 2007 was estimated from the observations collected weekly by the Algaline-project. The water samples for chlorophyll-*a* analysis have been taken along the route between Travemünde and Helsinki with automatic water sampler on board Finnmaid ferry (Fig 1).

In the Gulf of Finland the spring bloom formed in March about a week earlier than normal, with the peak reaching its average level at the beginning of April, but it then declined almost two weeks earlier than usual at the end of April. The following summer peak, according to the measurements of chlorophyll-*a* concentrations in water, was reached at the beginning of July and it was twice as high as the long-term average in the Gulf of Finland and the Northern Baltic Proper.

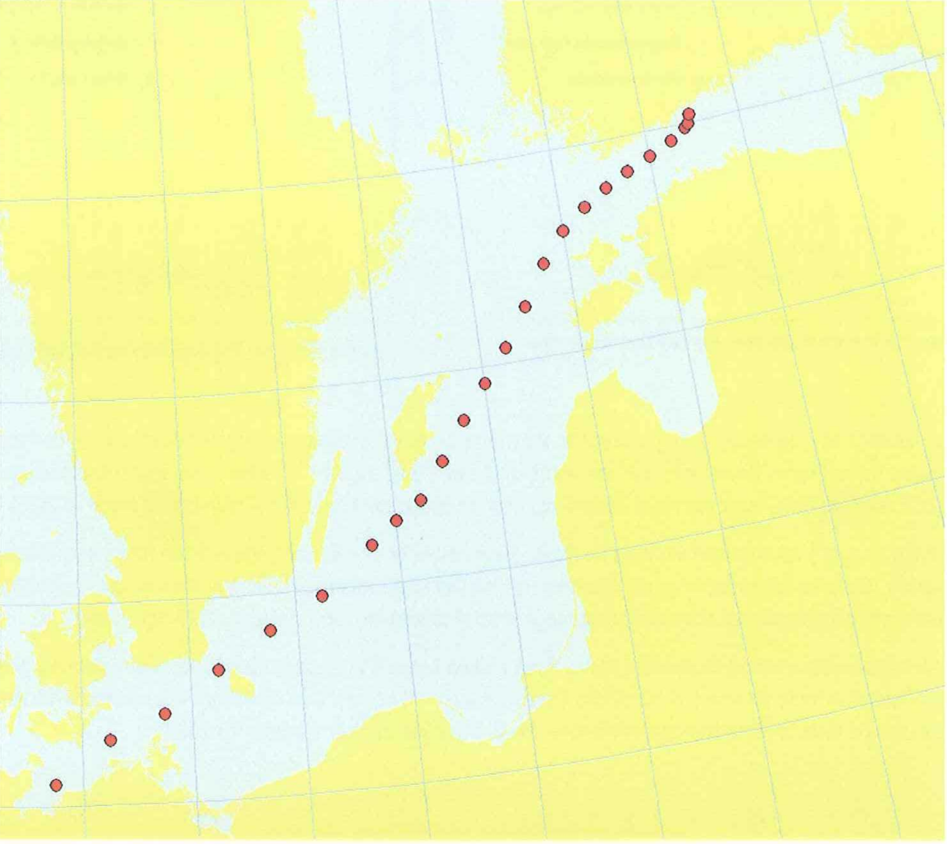


Fig. 1. Water sampling points for chlorophyll-*a* analysis.

Kuva 1. Vedenkeruupisteet klorofyllianalyysejä varten.

Bild 1. Lokaler för insamling av vattenprov för klorofyllanalyser.

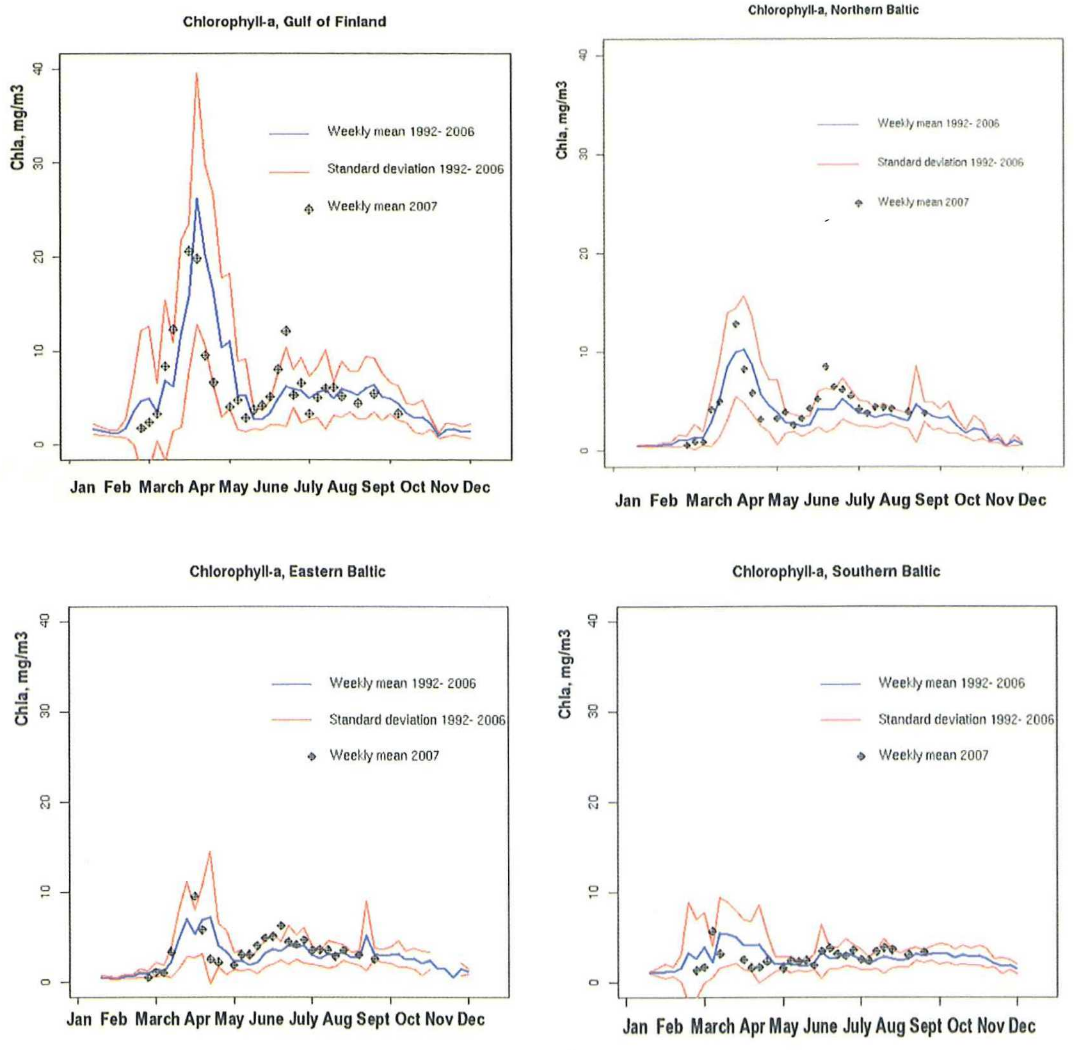


Fig. 2. Annual variation of chlorophyll-*a* (mg m^{-3}) in the Western Gulf of Finland (upper left), the Northern Baltic Proper (upper right), the Eastern Baltic Proper (lower left) and the Southern Baltic (lower right). The blue curve represents the average for the years 1992–2006, and red lines mark standard deviations, and the black stars are the measurements made in 2007.

Kuva 2. Klorofyllin (mg m^{-3}) vuosittainen vaihtelu läntisellä Suomenlahdella (ylävasen), Varsinaisen Itämeren pohjoisosassa (yläoikea), Varsinaisen Itämeren itäosassa (alavasen) ja Itämeren eteläossassa (alaoikea). Sininen viiva kuvaa keskiarvoja vuosilta 1992–2006, punaiset viivat kuvaavat standardipoikemia ja mustat tähdet kuvaavat vuoden 2007 havaintoja.

Bild 2. Mellanårsvariationen i klorofyllhalterna i västra Finska viken (uppe till vänster), norra Egentliga Östersjön (uppe till höger), östra Egentliga Östersjön (nere till vänster) och södra Östersjön (nere till höger). Den blåa linjer visar årsmedelvärdena för perioden 1992–2006 och de röda linjerna standardavvikelsen. De svarta stjärnorna är värdena för 2007.

Cyanobacterial blooms

The cyanobacteria bloom forecast for the coming summer was compiled in April–May in cooperation with SYKE. The prediction was based on winter nutrient concentrations and late spring phosphorus concentrations in the surface layer, with the ecosystem model run for alternative summer weather conditions. The cyanobacteria bloom forecast for the summer of 2007 predicted considerable cyanobacterial blooms to occur in the Southern and moderate blooms in the Central Baltic Proper, with a considerable risk for blooms in the Archipelago Sea and in the western Gulf of Finland.

The cyanobacteria bloom forecast succeeded quite well for the Gulf of Finland and the Archipelago Sea, but in the southern and central Baltic no marked blooms occurred (Fig. 3 and 4).

In Figure 4 the high chlorophyll-*a* in Bothnian Bay may be over-estimated due to high concentrations of yellow substance (CDOM).

The first cyanobacteria blooms were observed in mid-June in the Gulf of Finland and the Archipelago Sea. The blooms were formed by non-toxic *Aphanizomenon flos-aquae.*

Towards the end of July, algal blooms at the surface were rare in the Gulf of Finland, the Archipelago Sea and the sea areas south of the Åland Islands. However, the phytoplankton concentrations remained as high as during the previous week, though mixed in the water column.

Based on the phytoplankton monitoring by FIMR (see below), the late summer phytoplankton consisted of bloom-forming filamentous cyanobacteria (1/3 of the biomass) and diverse small motile flagellated algae (mainly chryso- and haptophytes, 2/3 of the biomass).

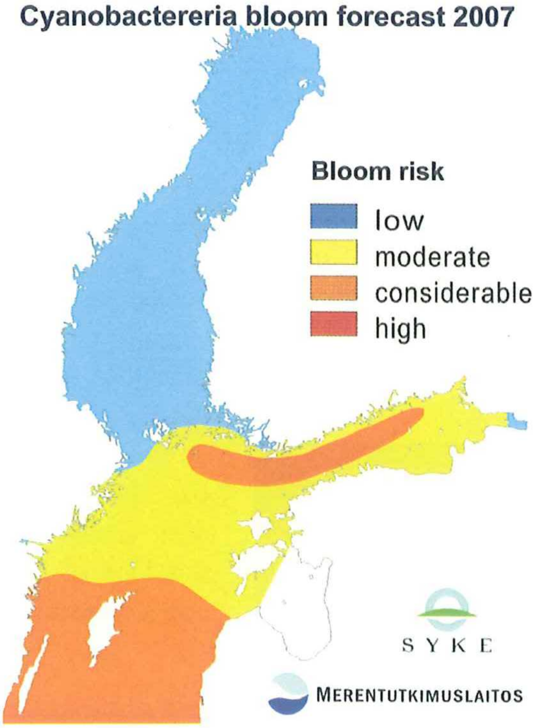


Fig. 3. Forecast in May 2007 for the cyanobacteria bloom in summer.

Kuva 3. Toukokuun 2007 sinileväennuste tulevalle kesälle.

Bild 3. Prognosen för blågrönalgs-blomningar 2007.

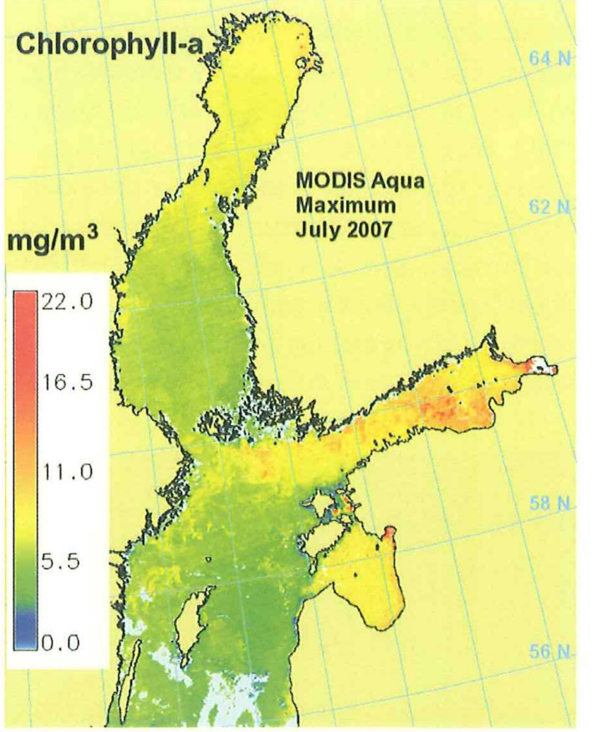


Fig. 4. Chlorophyll-*a* maximum for July 2007 estimated by MODIS Satellite.

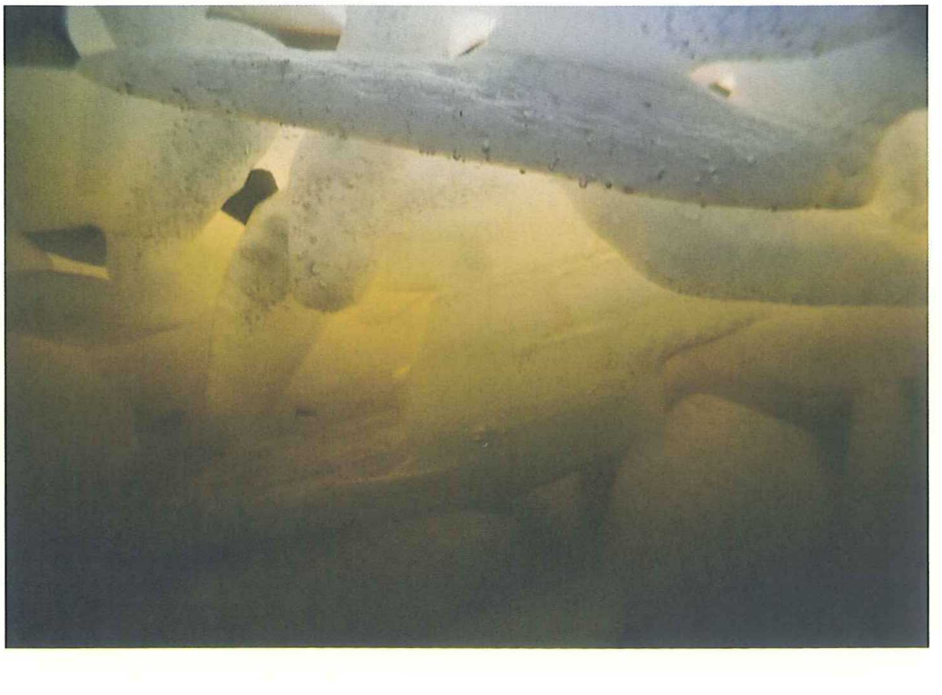
Kuva 3. MODIS-satelliittikuvista arvioidut klorofyllimaksimit heinäkuulle 2007.

Bild. 4. Ur MODIS-satellitbilder uppskattade klorfyllmaxima i juli 2007.

Phytoplankton abundance and biomass

As a contribution to HELCOM monitoring, late summer phytoplankton species composition and biomass have been determined at FIMR since 1979 from a geographically representative set of sampling stations in sea areas surrounding Finland. In the following, an overview of data from the last seven years is presented. The data are based on the results of an annual monitoring cruise typically taking place in August. Sampling and analysis have been conducted according to the 'Manual for Marine Monitoring in the COMBINE Programme of HELCOM' and FIMR's internal accredited QA. Each year's results represent a single sample pooled from the upper 10 m of the water column.

In the Gulf of Finland, phytoplankton abundance (Fig. 5) and consequently biomass (Fig. 6) were at their a highest levels in August 2007 since the year 2001. Although bloom-forming filamentous cyanobacteria (Nostocophyceae) constituted a considerable portion of the biomass, diverse small motile flagellated algae (mainly chryso- and haptophytes) dominated the phytoplankton biomass. Autotrophic ciliate *Mesodinium Rubrum* (Ciliophora) was also visible in the phytoplankton biomass. In the Gulf of Bothnia, including the Bothnian Bay and the Bothnian Sea, the late summer phytoplankton biomass and composition in 2007 were typical for the sea area. In the Bothnian Bay, the phytoplankton community mainly consisted of small flagellated algae (prasino-, hapto- and chrysophytes). *Mesodinium Rubrum* also formed a significant portion of the biomass. In the Bothnian Sea, small flagellated algae, mainly chryso- and haptophytes dominated phytoplankton abundance and biomass. The biomass share of bloom-forming cyanobacteria was lower in 2007 compared with the years 2004–2005. In the Åland Sea, cyanobacteria made up more than 50 % of the algal biomass in 2007, otherwise the biomass composition was rather similar to that in the Gulf of Finland. In the Northern Baltic Proper, the phytoplankton biomass was, according to our data, at its highest level in 2007 since the year 2001. Dinoflagellates (Dinophyceae) and bloom-forming cyanobaceria were the most important groups by biomass, with an almost equal biomass share. Small flagellated algae, mainly hapto- and prymnesiophytes, were the most abundant groups. In general, sparse sampling and significant inter-annual variation in phytoplankton species composition limits the possibilities for detailed data analysis in this kind of concise presentation.



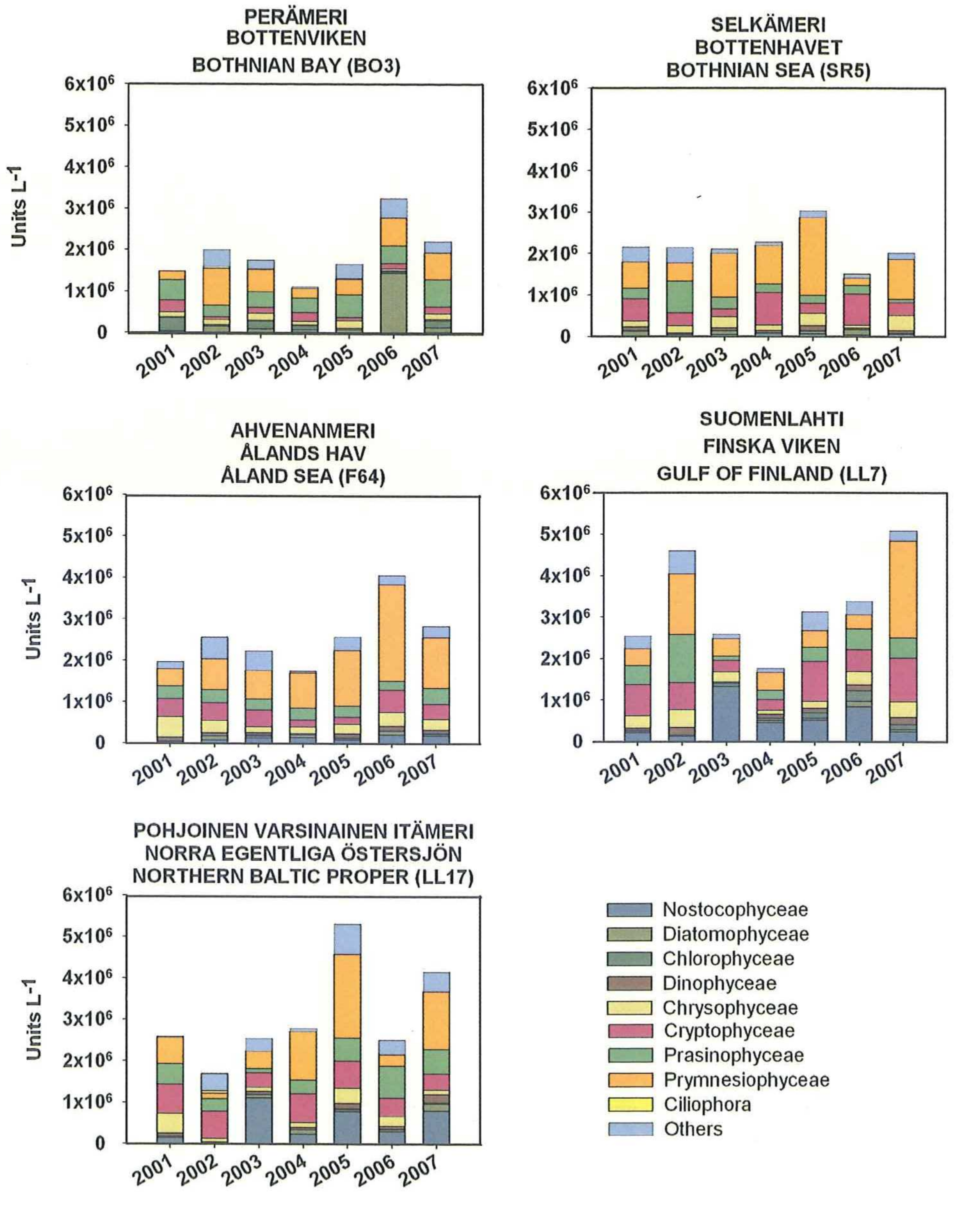


Fig. 5. Abundance of the main phytoplankton groups at selected open-sea monitoring stations representative of the sea areas mentioned above. The sampling station is given in parentheses after the sea area name.

Kuva 5. Kasviplanktonryhmien runsaus merialuetta edustavilla seuranta-asemilla. Seuranta-asema on suluissa merialueen jälkeen.

Bild. 5. Växtplanktonmängden fördelad på olika växtplanktongrupper på utsjömonitoringstationer representativa för Östersjöns olika delbassänger. Stationens namn anges inom parentes efter namnet på bassängen.

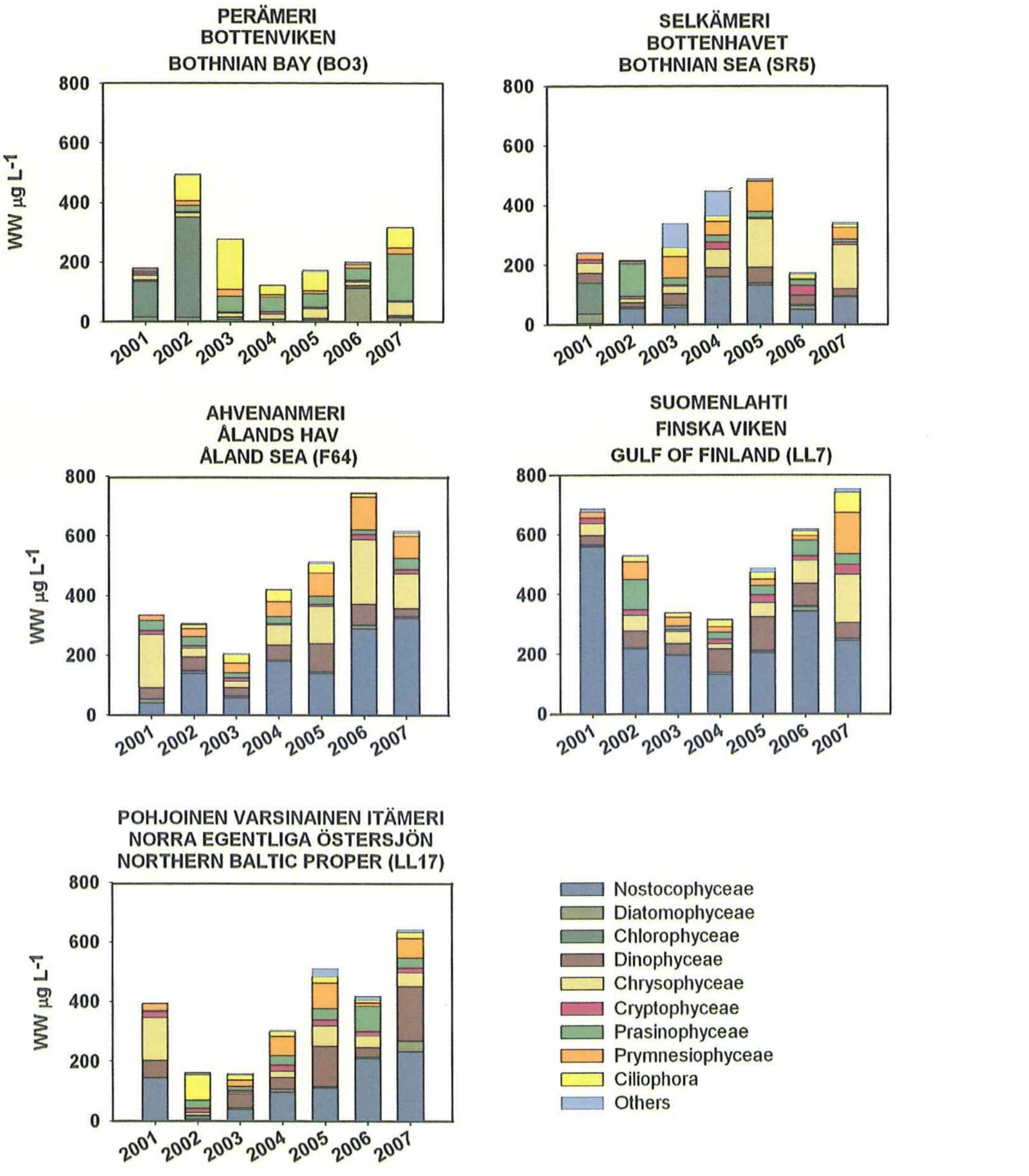


Fig. 6. The biomass (wet weight) of main phytoplankton groups at selected open-sea monitoring stations representative of the sea areas mentioned above. The sampling station is given in parentheses after the sea area name.

Kuva 6. Kasviplanktonryhmien biomassa (märkäpaino) merialuetta edustavilla seuranta-asemilla. Seuranta-asema on suluissa merialueen jälkeen.

Bild 6. Biomassan (våtvikt) för olika växtplanktongrupper för ovannämnda delbassänger. Stationens namn anges inom parentes efter namnet på bassängen.

Long-term trends in chlorophyll-*a*

Summer to early autumn surface water chlorophyll-*a* measurements have been made in the open sea areas surrounding Finland since 1972. In the Northern Baltic Proper and the Gulf of Finland, the chlorophyll-*a* concentration has increased steadily from the 1970s until 2007. The increase has been most distinct in the Gulf of Finland, where the mean concentration has more than doubled since the early 1970's. In the Bothnian Sea the chlorophyll-*a* concentration increased from the late 1970's to the late 1990's, but has decreased thereafter. The chlorophyll-*a* concentration in the Bothnian Bay has remained low since the beginning of data collection.

Chlorophyll-*a* -data froma depth of ≤ 2 metres were obtained from the databases of the Finnish Institute of Marine Research (FIMR) and the International Council for the Exploration of the Sea (ICES), the compilation of the data set resulting in a total of 1099 observations between the years 1972 and 2007. Late summer to early autumn (June to September) represents the time of the year in the phytoplankton seasonal succession when various flagellates and cyanobacteria are abundant. The development of chlorophyll-*a* was examined in the open sea areas surrounding Finland: the Bothnian Sea, the Bothnian Bay, the Northern Baltic Proper and the Gulf of Finland.

Phytoplankton monitoring with flow-through system

The Algaline-project has collected monitoring data on board commercial vessels since 1992. 12 or 24 weekly water samples have been taken during the phytoplankton growth season along the route between Travemünde and Helsinki. The water flow-through system includes an automatic refrigerated sequential water sampler, taking samples for supplemental analysis, such as inorganic nutrients, phytoplankton species composition and chlorophyll-*a* with extraction method in the laboratory. The approximate sampling points are show in Fig 1.

The annual succession of phytoplankton presented here is based on Alg@line monitoring, with the flow-through automatic recording system installed on board the ferry Finnpartner. The long term weekly means were compared to the 2006 weekly means.

Kasviplanktonseuranta kauppalaivoilla läpivirtauslaitteiston avulla

Algaline-seurantaprojekti on kerännyt kauppalivoilla tapahtuvan seurannan avulla havaintoja jo vuodesta 1992 alkaen. Noin viiden metrin syvyydeltä keräävän läpivirtauslaitteiston avulla mitataan laivan kulkiessa suolapitoisuus, lämpötila ja klorofyllifluoresenssi noin 250 m välein. Sen lisäksi laitteisto kerää viikoittain 24 vesinäytettä Helsinki – Travemünde reitillä epäorgaanisten ravinteiden ja kasviplanktonlajiston määrittämiseksi. Näytteenottopaikat on esitetty kuvassa 1. Havainnoista tiedotetaan viikottain Internetissä Algalinen leväseurantasivuilla www.itämeriportaali.fi.

Kasviplanktonin vuosittainen kehityksen seuranta perustuu Algaline-seurantaan, joka suoritetaan FINNMAID-kauppalaivalla. Kuluneen vuoden kasviplanktonin määrän kehitys havainnollistetaan klorofyllipitoisuuksien avulla, mikä kuvaa kasviplanktonin biomassan kehitystä. Viikkokeskiarvojen kehitystä verrataan pitkäaikaisten viikkokeskiarvojen kehitykseen.

Växtplanktonmonitoring genom "flow through"apparatur på handelsfartyg

Algalineprojektet har, sedan år 1992, insamlat monitoringdata genom automatiska mätinstrument installerade på handelsfartyg. Provtagningen och datainsamlingen bygger på ett "flow through"system där vatten från c. 5 m djup flyter igenom automatiskt registrerande instrument, som under fartygets gång mäter salthalten, temperaturen och klorofyllfluorecensen med c. 250 meters mellanrum. Dessutom insamlas 24 vattenprov i veckan på linje Helsingfors – Travemünde för bestämning av oorganiska närsalter och växtplanktonets artsammansättning. Bild 1 visar provtagningslokalerna. Observationerna redovisas veckovis på internet, www.itämeriportaali.fi.

Uppföljningen av växtplankton förekomsterna under året bygger på Algaline-monitoringverksamheten och utförs på handelsfartyget FINNMAID. Algsituationens utveckling under det gångna året åskådliggörs genom att följa med klorofyllvärdena, vilka speglar planktonbiomassan. Medelvärdena för de olika veckorna jämförs med långtidsmedelvärdena för motsvarande veckor.

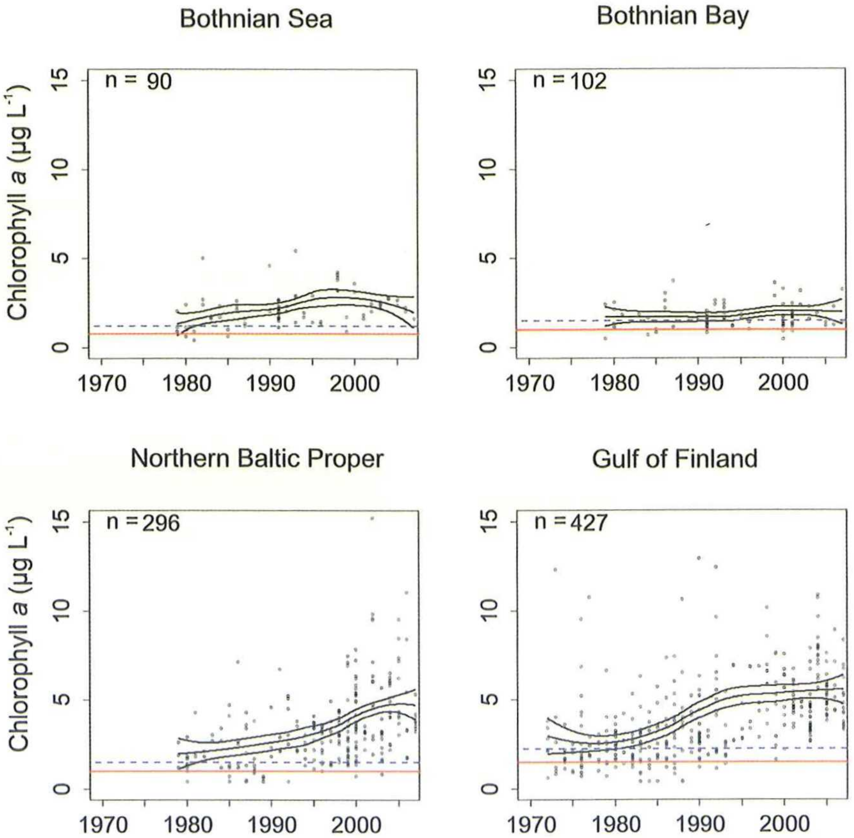


Fig. 7. Concentration of chlorophyll-*a* (µg L^{-1}) in the Bothnian Sea, the Bothnian Bay, the Northern Baltic Proper and the Gulf of Finland. Loess curve with 95-percent confidence intervals (solid black lines) is fitted to describe the long-term variation. The number of observations (n) as well as the tentative reference conditions (solid red line) and the targets (broken blue line) used in the Baltic Sea Action Plan are presented.

Kuva 7. Klorofyllipitoisuudet (µg L^{-1}) Selkämerellä, Perämerellä, pohjoisella Itämerellä ja Suomenlahdella. Loess-käyrä ja 95 % luottamusvälit (musta viiva) kuvaavat pitkäaikaiskehitystä. Havaintojen lukumäärät (n) sekä Itämeren toimenpideohjelmassa määrätyt referenssi- (punainen viiva) ja tavoitetasot (sininen katkoviiva) on esitetty.

Bild 7. Klorofyllhalterna (µg L^{-1}) i Bottenhavet, Bottenviken, norra Egentliga Östersjön och Finska viken. Loess-kurvan med 95% konfidensintervall (svarta heldragna kurvor) har räknats ut för att beskriva långtidsvariationen. Referensnivån (röd linje) och målsättningen (bruten blå linje), som fastställts i aktionsplanen för Östersjön, är angivna. Antalet observationer för varje delområde finns också angivet (n).

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7. ZOOPLANKTON IN THE BALTIC SEA IN 2007

Juha Flinkman, Soili Saesmaa & Jan-Erik Bruun

Introduction

The Baltic Sea is a large brackish water basin characterised by practically subarctic conditions. The water exchange between the Baltic Sea and the oceans is very restricted, whereas the Baltic drainage basin and annual precipitation are considerable. The Baltic is hence a very difficult environment for marine organisms, making the species assemblages a mixture of marine and freshwater species (Remane 1934, Segerstråle 1969).

In this respect, the plankton communities are no exception. Crustacean mesozooplankton, which are under observation here, consists of calanoid and cyclopoid copepods and caldocerans, that are of neritic and limnic origin.

Crustacean mesozooplankton form an important link in transferring energy from primary producers to consumers, namely the fish. They are in turn exploited by humans, which makes the food web short and efficient. Hence, changes in zooplankton assemblages are reflected directly and rapidly in fish growth, stock conditions, etc. Both bottom-up and top-down effects on higher levels of the Baltic pelagic food web have been demonstrated, recently highlighting the density-dependent processes. (e.g. Flinkman & al 1998, Möllmann & Köster 1999, Möllmann & al. 2005, Casini & al. 2006). Both processes, bottom-up and top-down, are mediated to economically significant resources, fish, through zooplankton. Therefore, monitoring of the zooplankton is important, as it gives a good insight into the status and development of the higher levels of the pelagic food webs.

Materials and methods

This zooplankton time series started in 1979 after the Convention on the Protection of the Marine Environment of the Baltic Sea Area, more usually known as the Helsinki Convention, had initiated the co-operational environmental monitoring of the Baltic Sea. It continues today, not as a HELCOM core parameter, but fortunately still undertaken by several Baltic countries. For a more detailed explanation on sampling and analysis, please refer to Flinkman & al. (2007).

Results and discussion

Since a complete time series analysis has already been given by Flinkman & al. (2007), we concentrate here on the abundances of major crustacean zooplankton taxa observed during summer 2007. These abundances are shown by station in Fig 1. When making comparisons to similar figures for 2006, it is essential to remember that the monitoring stations are sampled only once annually, hence a considerable proportion of the differences between two consecutive years may be caused by random events. Only longer time series reveal actual trends.

Baltic Proper

The hydrography of this main basin of the Baltic is characterized by strong stratification. Saline water forms the deep layer below a distinct halocline at ca. 70m depth. Water below the halocline is oxygenated only through saline water inflows, which results in oxygen-poor or anoxic conditions between inflow events.

The declining trend of the neritic copepod *Pseudocalanus acuspes* continued in 2007, showing even lower abundances at Baltic Proper stations than last year. Other copepod species *Temora longicornis*, the *Eurytemora* species group, *Centropages hamatus* and *Limnocalanus macrurus* follow an increasing trend. The *Acartia* species group is more abundant in this area than in2006, but it must be remembered that intercomparison between two consecutive years may be explained by random events (Fig. 1).

A declining trend is also evident in cladocerans. This trend is obvious in the neritic species *Evadne* and *Podon*. *Bosmina* seems to be more abundant at Gotland Deep (BY15) than in the previous year.

Gulf of Finland

The Gulf of Finland is directly connected to the Baltic Proper, without any sill which could prevent deep water from entering the gulf. The hydrography is therefore somewhat similar to that of the Baltic Proper, albeit the anoxic conditions at the bottom may be disrupted by wind mixing due to the shallowness of the gulf. However, due to anoxic Baltic deep water entering the gulf together with the presence of and severe eutrophication, anoxic conditions may occur, even rapidly, after well-mixed conditions.

Zooplankton communities in the Gulf of Finland show similar trends to those of the Baltic Proper, albeit not as clearly. The copepod species *Pseudocalanus acuspes* displayed a significant decreasing trend in the time series analysis (Flinkman & al. 2007), and this continued in 2007. However, *Centropages hamatus* , as well as the *Acartia* and *Eurytemora* species groups are more abundant in 2007. The cladocerans *Bosmina* and *Evadne* fit well into last year's observations, albeit they too are somewhat more abundant (Fig. 1). In fact, most taxa are more abundant in 2007, which suggests that monitoring sampling in 2007 occurred within a time range that was very favourable for crustacean zooplankton.

Bothnian Sea and Bothnian Bay

The Gulf of Bothnia system, which includes both the Bothnian Sea and the Gulf of Bothnia, is hydrographically different from the Baltic Proper and Gulf of Finland. A sill at a depth of 20–30m, formed along the southern edge of the Archipelago Sea and Åland Sea during the last ice age period, prevents the Baltic saline deep water from entering. Hence, the Bothnian Sea and Bay do not suffer from deep-water anoxia. Salinity is also lower, which can be seen in the zooplankton species composition. Neritic species like *Pseudocalanus* and *Centropages* are not present or are very rare, and freshwater species such as *Limnocalanus macrurus* are more abundant.

Overall, the zooplankton biomass of the Bothnian Sea and Bothnian Bay is increasing. Abundances of copepods and cladocerans are in accordance with observations of the previous years (Fig. 1).

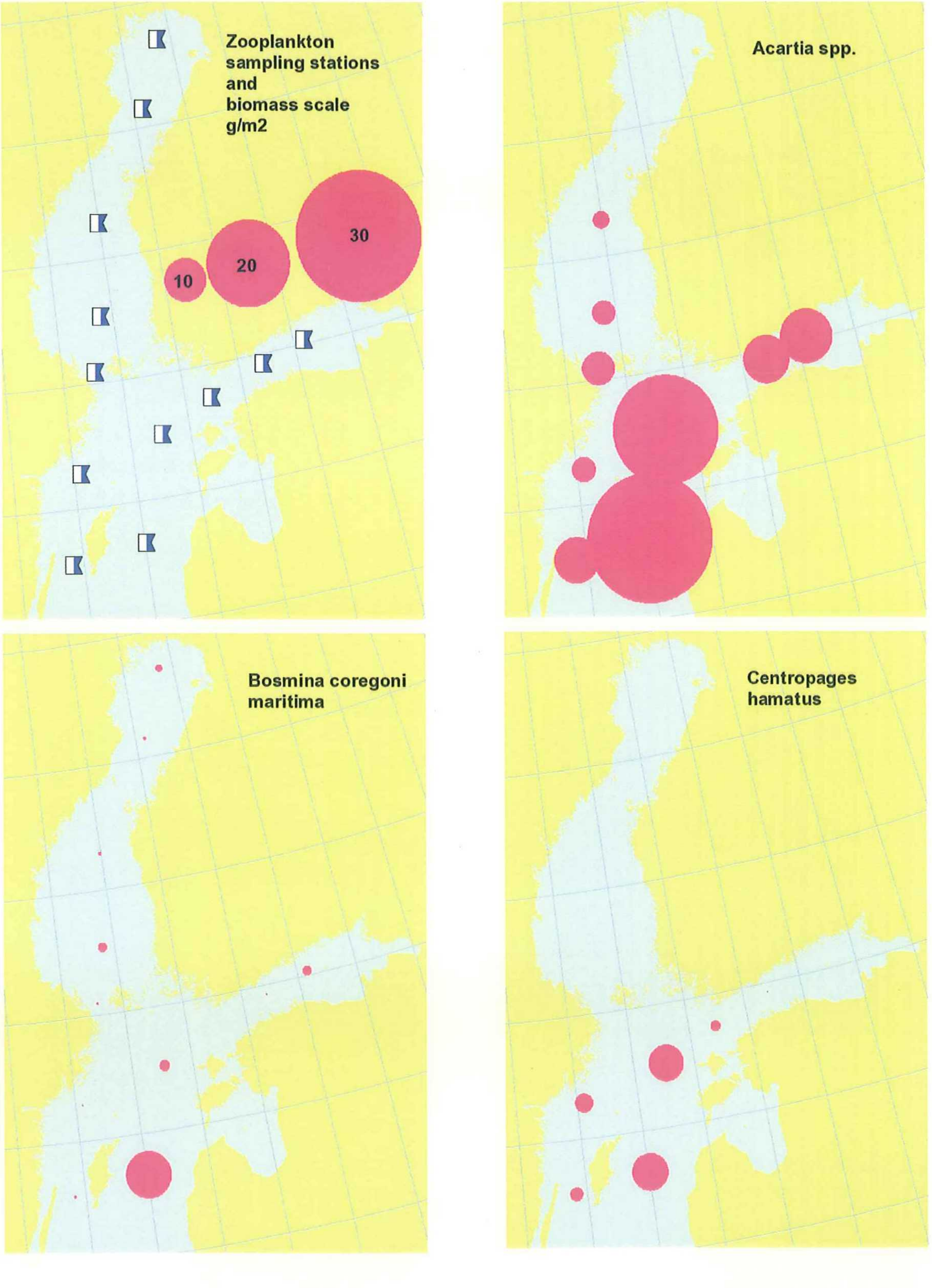
Conclusions

The trends already observed in the time series analysis for 1979–2006 seem to continue in all the sea areas. Some differences in biomass can be observed, but these can just as well be attributed to random events. The next few years, when added to the time series, will reveal how the zooplankton species composition develops in relation to salinity and deep water anoxia.

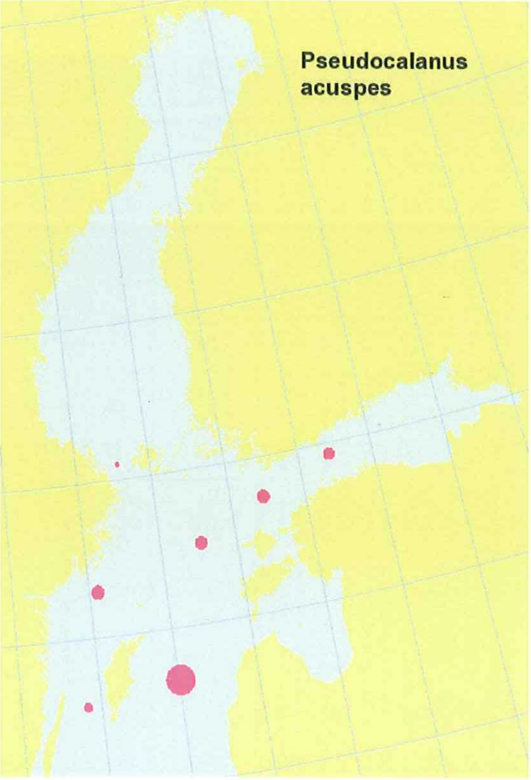
Fig. 1. Biomass (wet weight g/m²) of the most important crustacean zooplankton taxa at monitoring stations in the Northern Baltic Sea in late summer 2007.

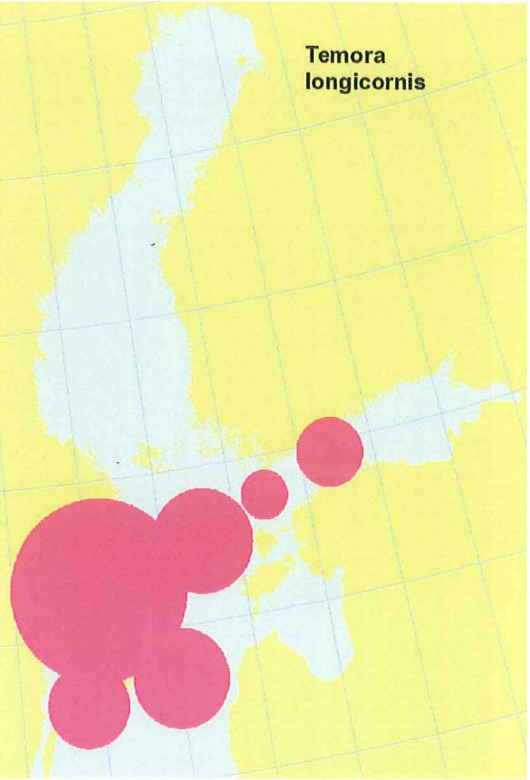
Kuva 1. Tärkeimpien äyriäisplanktonryhmien biomassat (märkäpaino g/m²) pohjoisen Itämeren seuranta-asemilla loppukesällä 2007.

Bild 1. Biomassavärdena (g/m², våtvikt) för de viktigaste planktiska kräftdjursgrupperna på monitoringstationerna i norra Östersjön sensommaren 2007.




Eurytemora affinis
Evadne nordmanni
Limnocalanus macrurus
Podon spp.





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8. THE AMERICAN COMB JELLY *MNEMIOPSIS LEIDYI* HAS INVADED THE NORTHERN BALTIC SEA

Maiju Lehtiniemi, Tarja Katajisto & Juha Flinkman

Introduction

A recent newcomer to the Baltic Sea is the American comb jelly, *Mnemiopsis leidyi* A. Agassiz 1865. This species originates in the estuaries and coastal regions of the east coast of North, Central and South America (Purcell & al. 2001). *M. leidyi* has been unintentionally introduced via ballast water into the Black Sea in 1982 (Vinogradov & al. 1989) and later, in 1999, into the Caspian Sea (Ivanov & al. 2000). The first recorded appearances of *M. leidyi* in northern European waters, in 2005, were in Oslofjorden, Norway (Oliveira 2007); later it was found in the North Sea, off the western coast of the Netherlands (Faasse & Bayha 2006), and then off the Swedish west coast, in the Kattegat region and the southern Baltic Sea in autumn 2006 (Javidpour & al. 2006, Hansson 2006). It is known to have a wide tolerance regarding environmental conditions, including 2–38‰ salinities, 2–32°C temperatures and low oxygen, which enables effective spreading to new areas (Purcell & al. 2001). The Black Sea was the first example of the damaging impact of *M. leidyi* on an ecosystem in general, especially on the pelagic community. The accidental introduction and subsequent outbreak of *M. leidyi* in the late 1980s resulted in a dramatic decrease in abundance of almost all prey species of pelagic fish, and also in the disappearance of some zooplankton species (e.g. Vinogradov & al. 1989, Purcell & al. 2001).

Sampling

Sampling was conducted on regular HELCOM monitoring cruises with R/V Aranda in August, September and December 2007. The samples were taken by vertical hauls using a WP-2 net (mesh size 500 µm) from the bottom to the halocline and from the halocline to the surface, according to the temperature and salinity profiles measured by CTD casts at each sampling site. At those stations where oxygen was depleted in deeper waters, the vertical tows were taken only from well-oxygenated water, from 50m to the surface. In December the tows were taken from the bottom to the surface. At stations where *M. leidyi* was most abundant in September, additional vertical tows (WP-2 net, mesh size 100 µm) were taken in order to assess the abundance of eggs.

Results and discussion

M. leidyi was most abundant in deep waters near the halocline. At stations where the abundances were highest, densities ranged from 4 to 24 ind m^{-3} at depths of 50–80m. The bulk of the population remained below the thermocline (~below 30m) with densities above it always being <1 ind m^{-3}. The most abundant stages were cydippid larvae, which occurred higher in the water column than the adults. The largest individuals recovered were 15mm long, indicating early reproduction. In December, only larvae (1–2mm long) were found. Eggs were found in the Åland Sea in September from depths of 155 to 50 m, with the highest abundances (90 egg m^{-3}) occurring around the halocline at 80-60m (temperature 4.5–5°C). Eggs at different developmental stages were present, and hatching of the final stage, i.e. embryo with tentacles still within the egg envelope, was observed.

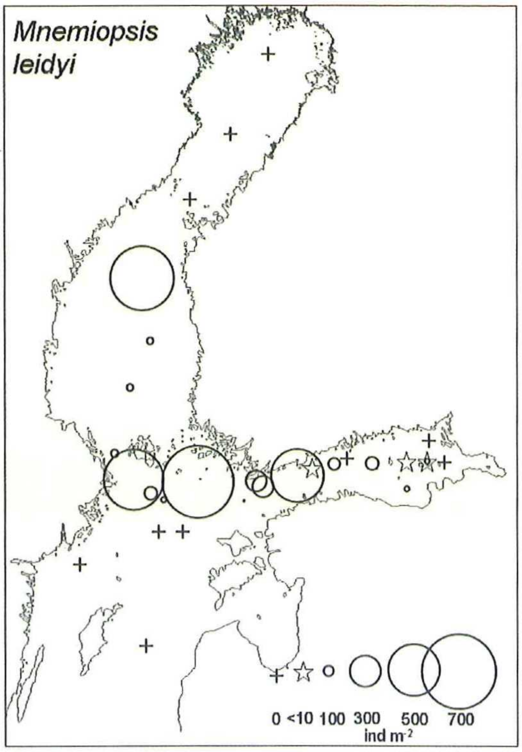

Fig. 1. Occurrence and abundance of *Mnemiopsis leidyi* in August, September and December 2007 in the northern Baltic Sea during cruises of R/V Aranda

Kuva 1. Amerikankampamaneetin (*Mnemiopsis leidyi*) esiintyminen ja runsaus pohjoisella Itämerellä elo-, syys- ja joulukuun 2007 mta Arandan matkoilla otettujen näytteiden perusteella.

Bild 1. Utbredningen och populationstätheten (ind./m²) för den amerikanska kammaneten *Mnemiopsis leidyi* enligt observationer gjorda på forskningsfartyget Arandas expeditioner i augusti, september och december 2007.

The distribution of *M. leidyi* in the northern Baltic Sea seems to be limited either by low salinity (no observations below 5 PSU) or low deep water oxygen levels (no observations at stations where oxygen was depleted below 60–70m). Based on our data, it seems that *M. leidyi* has established populations in the northern Baltic Sea and will survive winter in water layers around the halocline. The December observations of small individuals at low abundances also indicate overwintering as shown in the southern Baltic Sea (Kube & al. 2007). In its native areas and in the Black Sea and adjacent waters, population density seems not to be limited by salinity, but does decrease towards winter due to the temperature decline (Purcell & al. 2001). In the northern Baltic, the most important factor reducing its abundance is probably decreasing food availability due to cooling of the surface waters and decreasing plankton productivity towards late autumn and winter (Viitasalo 1992). In the Caspian Sea, where individuals were mostly small, indicating early reproduction, the species invaded almost the entire sea in less than a year (Ivanov & al. 2000). The rapid expansion of this invader in the Baltic Sea is similar to the invasion of the Caspian Sea. The high abundances observed and, especially, the high numbers in the larval stages indicate establishment of the species. The magnitude of the effect of this species on the Baltic ecosystem has yet to be established, but in similar eutrophic systems where similar prey taxa (e.g. *Centropages* spp., *Acartia* spp., *Eurytemora affinis* and cladocerans) are present, invasion by this ctenophore has profoundly changed the ecosystem (reviewed by Purcell & al. 2001).

The most recent alien invasive species in the Baltic Sea is a ctenophore *Mnemiopsis leidyi,* which was found in the southern Baltic in late autumn 2006. It has now spread to the northern part of the Baltic Sea as well, and was found in the western Gulf of Finland, in the Åland Sea (max 694 ind m^{-2}) and in the Bothnian Sea (max 619 ind m^{-2}) in August-September 2007. No individuals were found north of the Quark, probably due to the low salinity of the Bothnian Bay water . *M. leidyi* was observed to reproduce, indicating adjustment of the species to the conditions of the northern Baltic Sea. In December *M. leidyi* was found in low abundances in the eastern Gulf of Finland. Thus, it is most probable that *M. leidyi* survives over winter.

Itämeren uusin tulokaslaji on amerikankampamaneetti *Mnemiopsis leidyi*, joka löydettiin loppusyksyllä 2006 eteläiseltä Itämereltä. Nyt laji on levinnyt myös pohjoiselle Itämerelle. Amerikankampamaneettia löydettiin elo-syyskuussa Suomenlahdelta (max 508 yksilöä m^{-2}), Ahvenanmereltä (max 694 yksilöä m^{-2}) ja Selkämereltä (max 619 yksilöä m^{-2}). Laji ei ole levinnyt Perämerelle, luultavasti alueen alhaisen suolapitoisuuden vuoksi. *M. Leidyin* havaittiin lisääntyvän, mikä kertoo lajin kyvystä sopeutua ja asettua pohjoiselle Itämerelle. Joulukuussa amerikankampamaneettia löydettiin itäiseltä Suomenlahdelta alhaisina tiheyksinä. On siis hyvin todennäköistä, että laji selviää myös talvesta.

Den senaste nykomlingen i Östersjön är den amerikanska kammaneten *Mnemiopsis leidy*. Senhösten 2006 observerades den i södra Östersjön och har nu brett ut sig också till norra Östersjön. I augusti-september 2002 hittades maneten i västra Finska viken (max 508 individ m^{-2}), i Ålands hav (max 694 individ m^{-2}) och i Bottenhavet (max 619 individ m^{-2}). Arten har inte påträffats i Bottenviken, vilket troligen beror på den låga salthalten där. Observationerna visar att arten kan föröka sig i våra vatten, och sålunda är anpassningsbar och kan etablera sig i norra Östersjön. I december observerades *M. Leidyin* i mindre mängder i den östra delen av Finska viken. Det är sålunda mycket troligt att arten klara av också vinterförhållandena.

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ARANDA
HELSINKI

9. HARMFUL SUBSTANCES

Harri Kankaanpää & Mirja Leivuori

Introduction

The Baltic Sea has been subject to intensive chemical input for decades. Various chlorinated anthropogenic pollutants have entered the Baltic Sea and its food webs since the 1930's and 1940's when the bleaching of pulp with elemental chlorine and the production of chlorophenols as wood preservatives started. Use of polychlorinated biphenyls (PCBs) in electronic insulators and cooling systems had already begun in the 1920's. In addition to PCBs, the other major harmful organochlorine compounds within the Helsinki Commission (HELCOM) monitoring program are: dichlorodiphenyltrichloroethane (DDT, an insecticide produced since the 1940's): hexachlorobenzene (HCB, a fungicide used since 1945); α and γ-hexachlorocyclohexane (α-HCH and γ-HCH, insecticides produced since the 1940's). γ-HCH (lindane) was used widely in the 1970's. Use of all these compounds is now generally prohibited, but for example DDT is still employed in developing countries.

Environmental pollution by heavy metals started after 1900. For decades, heavy metals were discharged freely into the marine environment. In the 1970's environmental awareness increased and different national and international restrictions and legislations were established to reduce the heavy metal loads. Since then heavy metals have also been an integral part of the monitoring programme. Mercury, cadmium, lead, copper and zinc are the key trace elements indicating anthropogenic input. Mercury in tissues occurs mainly in organometallic forms (methyl mercury).

Ship traffic poses a threat to the marine environment in terms of oil spills, and such traffic is increasing in the Baltic Sea. Crude oil and engine oils contain a varying mixture of polyaromatic (PAHs) and aliphatic hydrocarbons. Particle-bound PAHs from the production of energy (especially from coal power plants) also enter the marine environment via the atmosphere. PAHs are notorious for being carcinogenic. All compounds exhibit varying degrees of toxicity, and are known to affect several key metabolic processes in organisms.

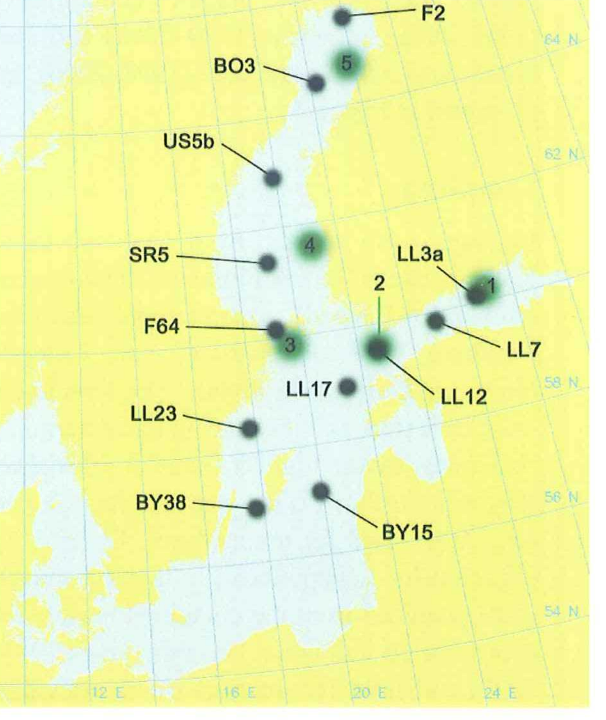

Fig. 1. Sampling areas for organochlorine and heavy metal monitoring in herring (green) and total oil monitoring in sea water (black). 1 = Kotka (east of LL3a), 2 = Hanko (overlapping with LL12), 3 = Åland, 4 = Pori, 5 = Kalajoki.

Kuva 1. Orgaanisten klooriyhdisteiden (silakka, vihreä), raskasmetallien (silakka, vihreä) ja kokonaisöljyn (pintavesi, musta) näytteenottoalueet. 1 = Kotka (LL3a:n itäpuoli), 2 = Hanko (päällekäin LL12:n kanssa), 3 = Ahvenanmaa, 4 = Pori, 5 = Kalajoki.

Bild 1. Provtagningsstationer för organiska klorföreningar och tungmetaller i strömming (grön) och totalhalter av olja i ytvattnet (svart). 1 = Kotka (öster om LL3a), 2 = Hangö (vid LL12), 3 = Åland, 4 = Björneborg, 5 = Kalajoki.

The Finnish Baltic Sea monitoring programme involves yearly analyses of the organic and inorganic contaminants mentioned above (except PAHs). This is carried out through the analysis of two-year-old herrings (main target) and, to lesser extent, three-year-old herrings. Use of two-year-old herrings as indicators is preferred because, when young, they are a local or regional species. Thus young herring, up to the time of their sexual maturity, are regarded as representative of the areas where they are collected.

Oil pollution in surface water (1 m depth) is being monitored at a number of locations in the northern, central and southern Baltic Sea regions; these locations, as well as those for herring sampling of organic contaminants (1985–2006), mercury (1979–2006) and cadmium, lead, copper and zinc (1998–2006), are presented in Figure 1.

Sampling

Herrings were caught from five sub-areas: Kotka (eastern Gulf of Finland), Hanko (western Gulf of Finland), Åland (Åland Sea), Pori (southern Gulf of Bothnia) and Kalajoki (northern Gulf of Bothnia). The specimens were collected, and the herring age determination made, by the Finnish Game and Fisheries Research Institute. Two-year-old female herrings were used for the analyses. Data on organochlorine compounds in herring muscle were produced from the combined muscle tissues from 10 individual herrings (years 1985–1997) and from the analysis of 10 individual herring muscle samples (from 1998 onwards). For heavy metals, two-year-old female herrings have been studied, but when the number of two-year-old herrings has been too low, three-year-old females have also been included.

The average sizes and ages (usually two years) of herrings examined in the HELCOM monitoring are clearly below those of the herrings caught commercially. The lower-limit length of herrings on the market is 13–14 cm, corresponding to an age of 4.0–4.3 years (source: Raimo Parmanne, Finnish Game and Fisheries Research Institute).

Organic compounds

A comprehensive analysis of the time-trends of organic chlorine compounds (PCBs, DDT and its metabolites and the pesticides γ-HCH and HCB) in Baltic Sea herring was published recently (Kankaanpää 2007). The trend analysis showed a statistically significant decrease in total PCB and DDT concentrations at all monitoring stations over time (1985–2006). An example for DDT is presented in Figure 2. Winter-period (1993–2007) trends in total oil in surface sea water (by fluorometry) were also examined, indicating a significant temporal decrease for nine monitoring areas. The analytical detection limits for total DDT are estimated to be reached by 2009–2011. No novel data regarding organochlorine compounds has been produced since the previous report. Total oil monitoring data from August 2007 are the only addition concerning organic contaminants. Summer-period total oil concentrations are less indicative of changes in oil pollution (Fig. 3). The concentrations at monitoring stations LL3a, LL7 and LL12 were 0.25±0.04, 0.14±0.02 and 0.21±0.03 $\mu g\ l^{-1}$, indicating typical residual polyaromatic hydrocarbon concentrations (background level).

Additionally, based on the results of the Finnish National Public Health Institute (NPHI), polychlorinated dibenzo-p-dioxins and dibenzo-p-furans are still rather high in herring (of the order of a few ng TEQ kg^{-1} ww in young herring). Swedish monitoring of dioxins in guillemot eggs indicates an approximately three-fold decline from the peak values of the 1970's and 1980's. Despite the residual contaminants, the NPHI recommends a modest use of Baltic Sea fish, including herring, in weekly consumption due to the health benefits of fatty acids.

The reduction of anthropogenic pollution in herring and oil in surface water is likely to continue, and will improving the environmental situation of the Baltic Sea ecosystem and the safety of marine food sources.

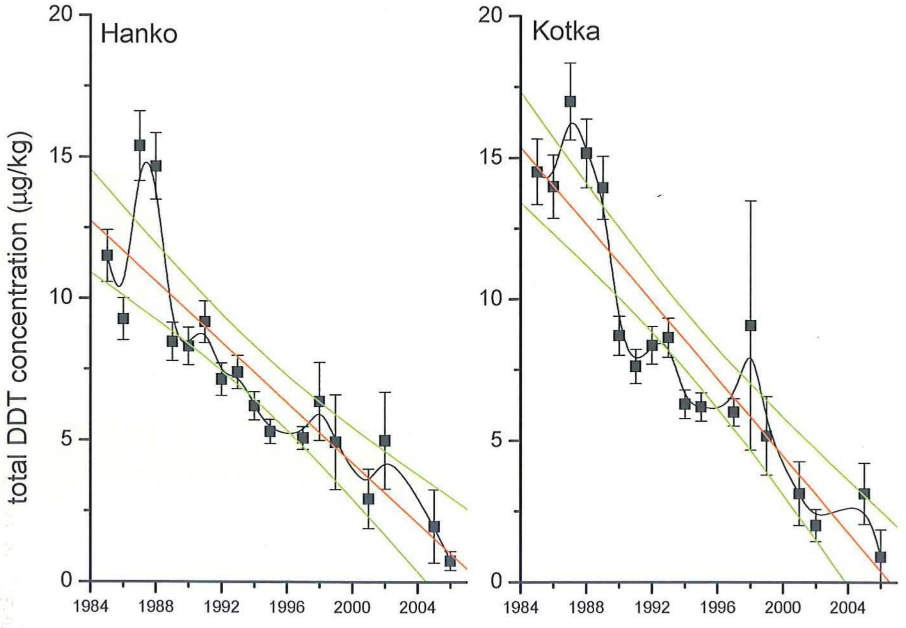

Fig. 2. Two examples of declining concentrations of total DDT (DDT + DDE + DDD) in two-year-old herring (Hanko and Kotka) during 1985–2006. All values are average concentration ± standard deviation (from sample set heterogeneity of error of measurement).

Kuva 2. Kaksi esimerkkiä laskevista kokonais-DDT -pitoisuuksista (DDT + DDE + DDD) kaksivuotiaassa silakassa (Hangossa ja Kotkassa) vuosina 1985–2006. Kaikki arvot on esitetty muodossa keskipitoisuus ± keskihajonta (näyte-erän silakoiden heterogeenisyyden tai mittausepävarmuuden pohjalta).

Bild 2. Två exempel på sjunkande halter av total DDT (DDT + DDE + DDD) i två-årig strömming (Hangö och Kotka) under perioden 1985–2006. Alla värden är angivna som medelkoncentration ± standardavvikelse (på basen av heterogeniteten hos strömmingarna i en provtagningsomgång eller mätningsosäkerheten).

Determination of organochlorine compounds in herring muscle

There are no organochlorine data for the years 2000, 2003 and 2004, nor DDT data for the year 1996, due to problems with quality control and sample storage.

Briefly, organochlorine compounds were extracted from either 1) freeze-dried herring muscle tissue using a mixture of acetone and hexane (samples from 1985 to 1999), 2) fresh, individual herring muscle tissues using the same extraction (samples of 2001–2002) or 3) freeze-dried individual herring muscle tissues extracted with a mixture consisting of petroleum ether, acetone, hexane and diethyl ether (samples of 2005). The extracts were finally analysed using gas chromatography (electron capture detector).

The analytical inaccuracy of the determination of different CB congeners (CB28, CB52, CB101, CB118, CB138, CB153 and CB180), DDT and its metabolites (DDE and DDE) plus pesticide (HCB, α-HCH and γ-HCH) concentration has been estimated as 12–22%, 4–8% and 8–13%, respectively (Pikkarainen & Parmanne, 2006). The sum parameters of total PCB and total DDT comprise the sum concentrations of the aforementioned compounds. The upper limits of inaccuracies were used as standard deviation values in the trend analysis.

For the years 1985–1987, the calculation of the total "sum of seven" CBs was based on calibration with the technical chlorobiphenyl mixture Aroclor. During that period of time there was only a limited availability of CB congeners as pure compounds. Congeners number 95, 101, 110, 118, 153 and 138, present in Aroclor, were the basis of the quantification. The "sum of seven" concentration was derived from the sum concentration from Aroclor by multiplying by 1.993. From 1988 onwards the quantification has been based on the use of pure congeners.

Determination of total oil concentration in seawater

Surface water (1 m) samples were collected from onboard R/V Aranda (Finnish Institute of Marine Research) using one-litre pre-washed glass bottles. The water was extracted with n-hexane and the total oil concentration analysed based on fluorescence (excitation 310 nm, emission 360 nm) in accordance with IOC (1984). Calibration was carried out using n-hexane solutions containing crude oil (from the Ekofisk field, Norway). The data span from 1992/1993 to 2006, with the exception of summer 2004 – summer 2005.

The inaccuracy of the total oil determination has been assessed using parallel seawater samples drawn from the same sampling location, thus representing total inaccuracy due to sample heterogeneity and analytical deviation. This inaccuracy was from 5.5 to 14%, depending on the total oil concentration (Pikkarainen & Lemponen, 2005). For the trend analysis, a 15% standard deviation has been applied.

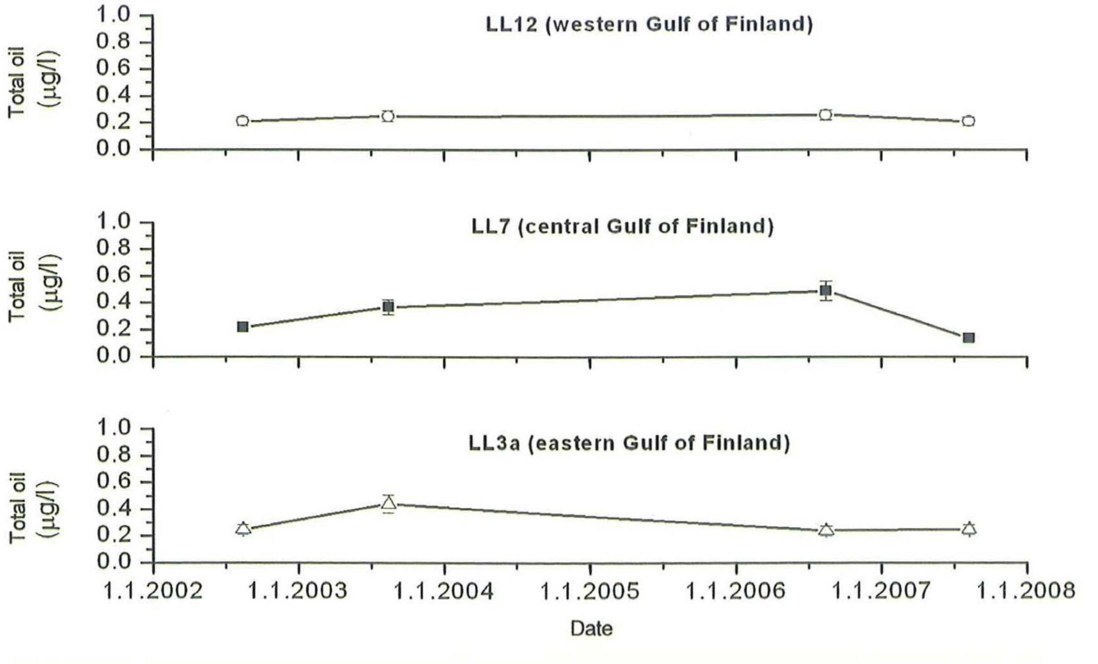

Fig. 3. Total oil concentrations in summer-period surface water at three monitoring sites in the Gulf of Finland (2002–2003 and 2006–2007), showing typically low concentrations.

Kuva 3. Kesäajan kokonaisöljypitoisuudet pintavedessä Suomenlahden kolmella seuranta-asemalla (vv. 2002–2003 ja 2006–2007) osoittavat tyypillisesti matalia pitoisuuksia.

Bild 3. Totalhalterna av olja i ytvattnet sommartid på tre övervakningsstationer i Finska viken (2002–2003 och 2006–2007) uppvisar generellt låga värden.

Heavy metals

Concentrations of lead were low – near the detection limit (0.03 mg kg^{-1} ww) – at all monitoring sites. The mean cadmium concentration in the individual livers of 2-year-old herrings had mainly decreased from the previous year in the areas studied, with the exception of slightly increased values at Hanko and Kotka (Fig. 4). Given the high statistical variability, however, no obvious change during the past few years can be seen.

The high mercury concentration found at Kalajoki in 2005 decreased in 2006. Levels of mercury increased at Kotka (Fig. 5). At Kalajoki and Kotka the variabilities in the mercury concentrations in particular were high, being highest in the Kotka area. The maximum measured mercury concentration at Kotka in 2006 was higher than the previous maximum in average concentrations in 1987. However, the average concentrations there show a decrease (pooled muscles; Fig. 6). No clear time-trends in mercury concentrations can be seen. The monitoring results for levels of mercury are, however, fairly low when compared with the EU limit for mercury in fish tissue (muscle) of 0.5 and 1.0 mg kg^{-1} ww (Table 1).

In 2006 no significant differences for mean concentrations of either zinc (15.4–28.1 mg kg^{-1} ww) or copper (2.93–4.25 mg kg^{-1} ww) were observed between the monitored stations. Concentrations mainly decreased from 2005, with the exception of slight increases at Kalajoki (Zn, Cu) and Hanko (Cu). More detailed data of heavy metals in Baltic herring from previous years have been reported in Leivuori (2007).

Overall, no clear changes were observed between the years 2005 and 2006 in any of the heavy metals in herring in the different monitoring areas (Fig. 1). There are some signs of decrease in mercury concentrations in the Bothnian Bay, although these have not been statistically examined. All concentrations remain low in the Bothnian Bay and the Åland Sea. Mercury concentrations are somewhat higher in the Gulf of Finland (Hanko and Kotka) than elsewhere. Due to the high inter-observational variability, clear time trends in mercury or cadmium cannot be seen.

In regard to food safety regulations, Table 1 summarises the situation. Organochlorine and heavy metal contamination is already at such a low level that consumption of two-year-old herring needs only very moderate regulation, if any. In older herrings, which are those usually on the market, concentrations are higher (e.g. Leivuori & al. (2003), Pikkarainen (2003), Hallikainen & al. (2004), Venäläinen & al. (2004)). Table 1 also includes data on organochlorines and heavy metals in two- and three-year-old herrings in 2006.

Determination of heavy metals

Heavy metals have been measured from individual herring muscles (Hg) and livers (Cd, Pb, Cu, Zn) since 1998. During the period 1979-1997 all monitored heavy metals were measured from pooled herring muscles; parallel studies with pooled muscles and individual muscles and livers were performed in 1998–2001. Since 1998, the measurements have been performed using methods accredited by the Finnish Accreditation Service (FINAS, accreditation code T040). Freeze-dried liver samples are digested with nitric acid by a laboratory microwave oven. Muscle samples (freeze-dried) are digested with nitric acid by autoclaving. Cadmium, lead and copper AAS measurements are made by flameless methods with matrix modification and platform techniques. The flame AAS-method is used for zinc measurements. For mercury, the cold vapour technique with amalgamation is used.

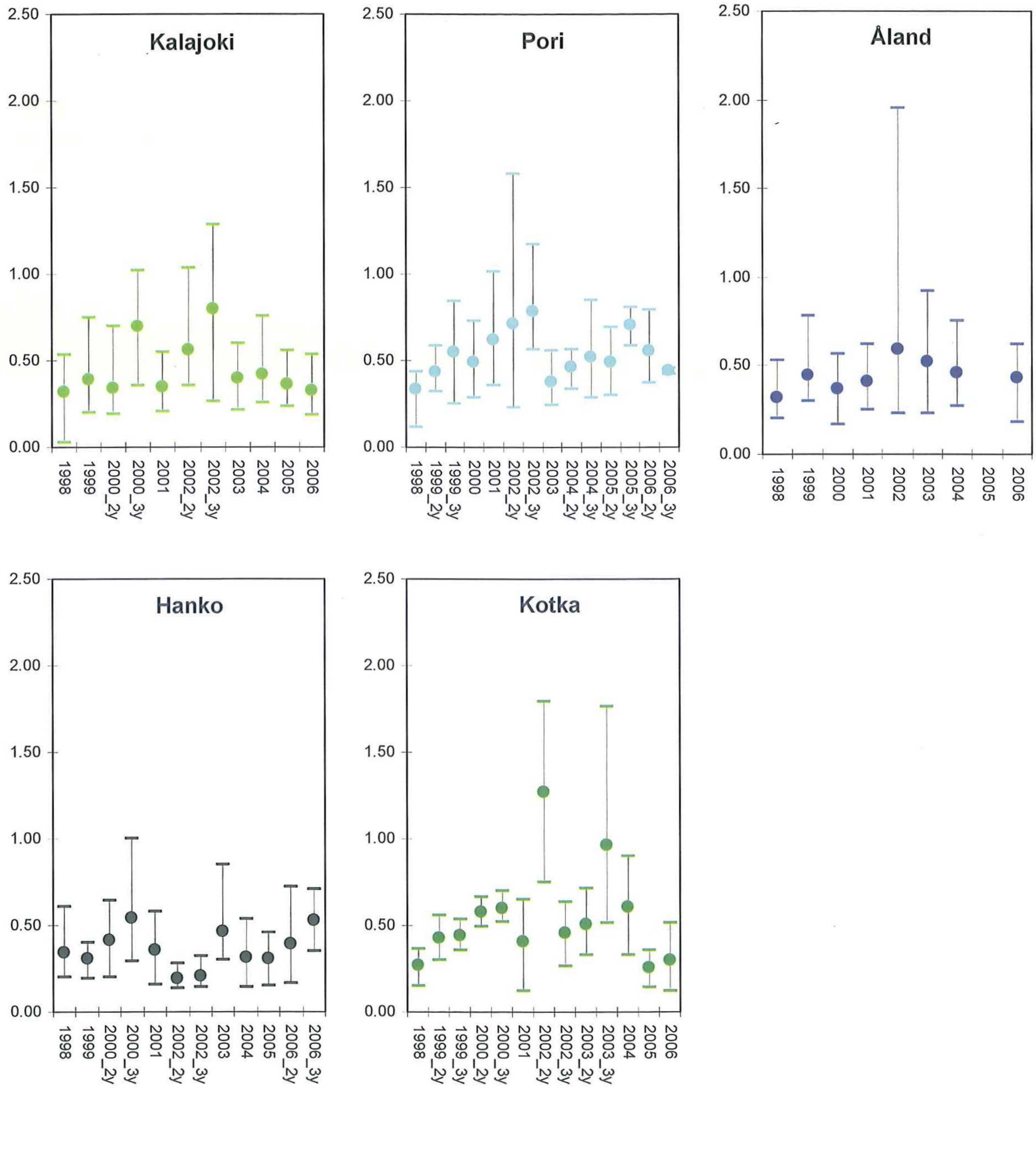

Fig. 4. Cadmium (Cd) concentrations (mg kg^{-1} ww) in two- or three- year-old female Baltic herrings displayed as mean, minimum and maximum values.

Kuva 4. Kadmiumin (Cd) pitoisuudet (mg kg^{-1} märkäpainoa) kaksi- tai kolmivuotiaissa naarassilakoissa (maksa). Pitoisuuksien keskiarvo, minimiarvo ja maksimiarvo on esitettynä.

Bild 4. Kadmiumkoncentrationer (Cd, mg kg^{-1} våtvikt) i levern hos två- eller treåriga honströmmingar (medelvärde, minimum och maximum).

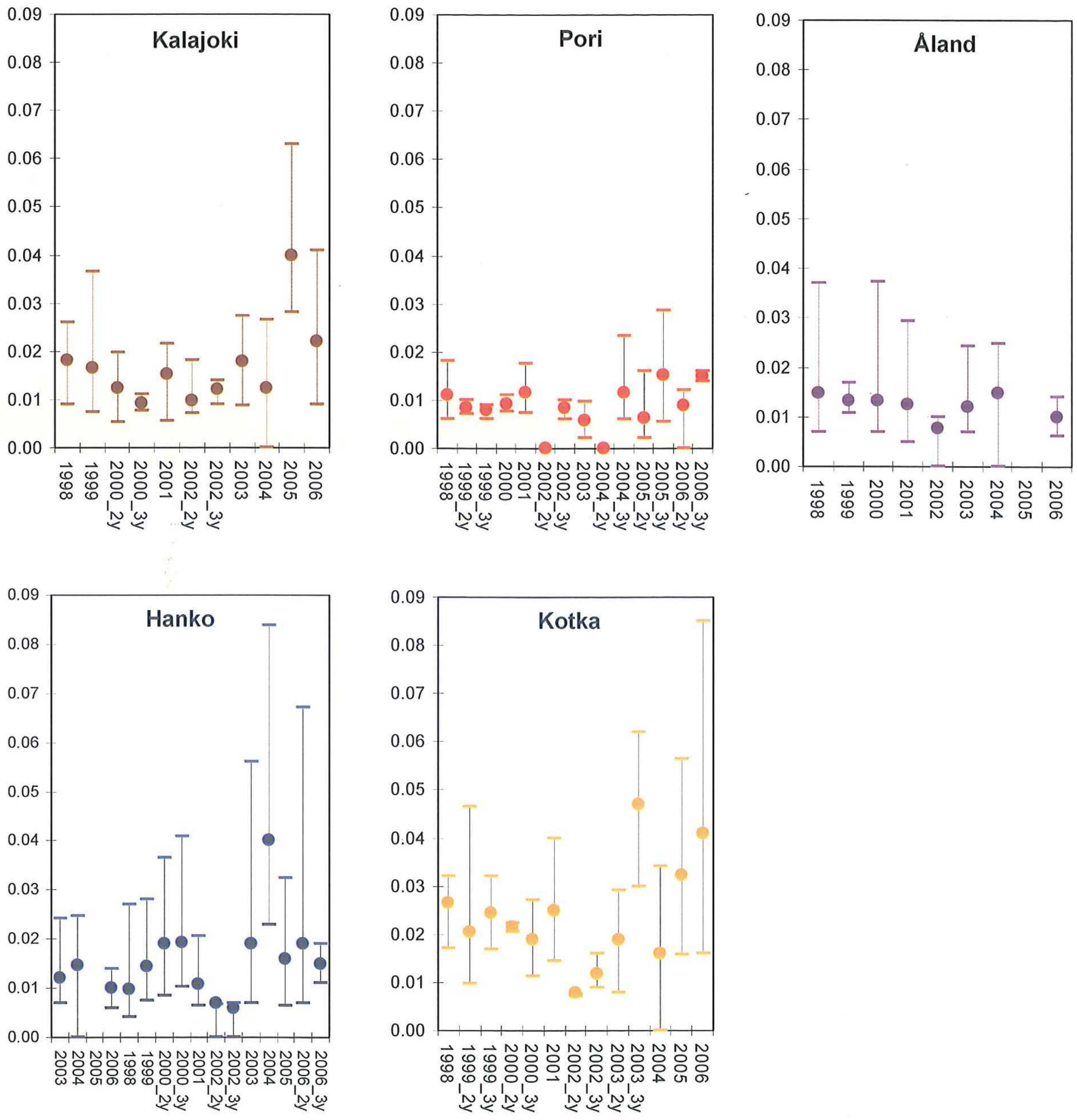

Fig. 5. Mercury (Hg) concentrations (mg kg^{-1} ww) in two- or three- year-old female Baltic herrings (muscle), displayed as mean, minimum and maximum values. Values below 0.01 mg kg^{-1} are below the limit of detection (0.006 mg kg^{-1} ww).

Kuva 5. Elohopean (Hg) pitoisuudet (mg kg^{-1} märkäpainoa) kaksi- tai kolmevuotiaissa naarassilakoissa (lihas). Pitoisuuksien keskiarvo, minimiarvo ja maksimiarvo on esitettynä. Pitoisuudet, jotka alittavat 0.01 mg kg^{-1} ovat havaintorajan (0.006 mg kg^{-1} ww) alapuolella.

Bild 5. Kvicksilverkoncentrationer (Hg, mg kg^{-1} våtvikt) i muskelvävnad hos två- eller treåriga honströmmingar (medelvärde, minimum och maximum). Koncentrationer under 0.01 mg kg^{-1} underskrider detektionsgränsen (0.006 mg kg^{-1} våtvikt).

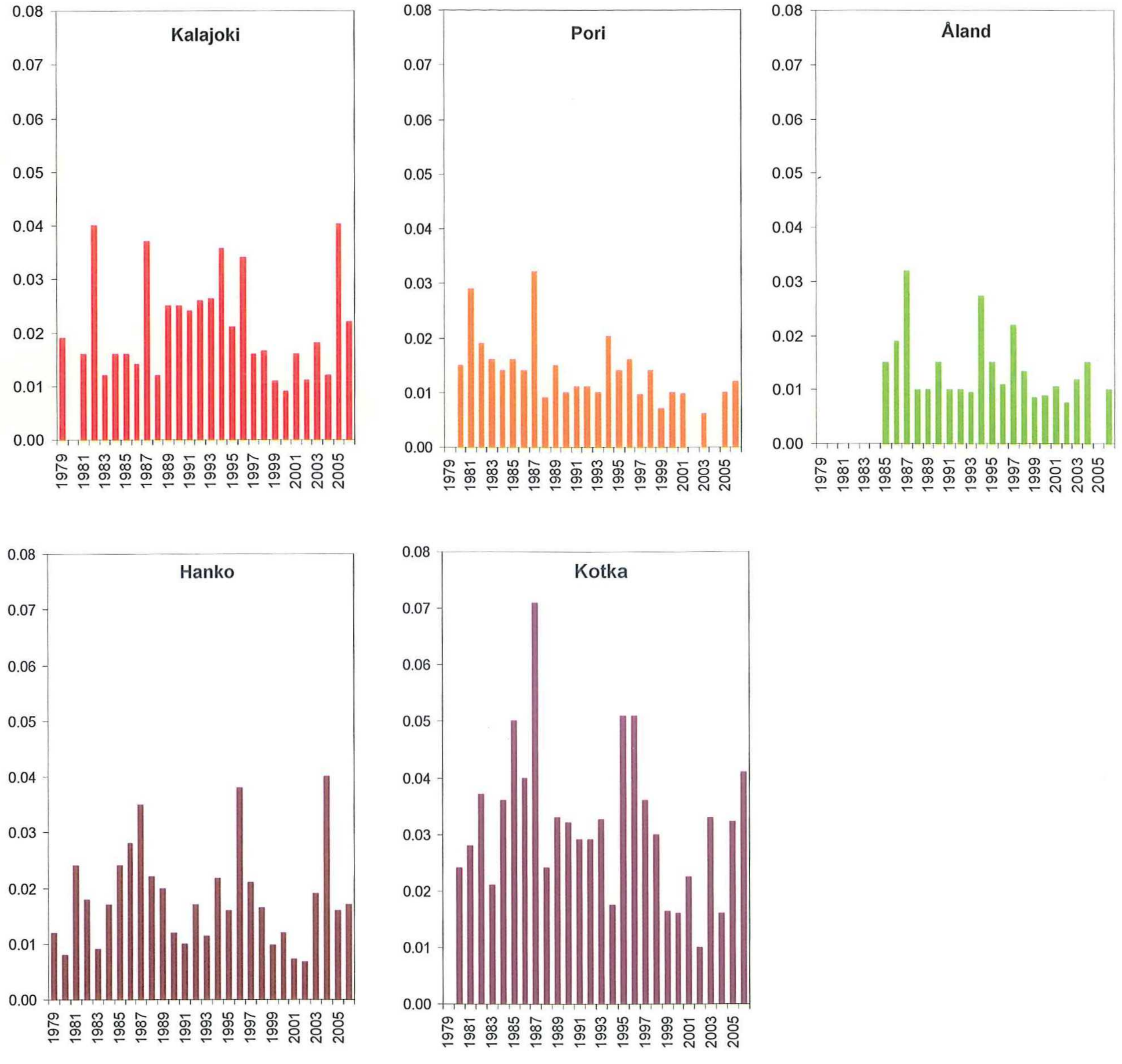

Fig. 6. Time series of mercury (Hg) concentrations (mg kg^{-1} ww) in Baltic herring muscle (two- or three- year-old female). Before 1998 pooled muscles were studied; since then, average values of individual muscles have been used. Standard deviations are not available.

Kuva 6. Elohopean (Hg) pitoisuusvaihtelut (mg kg^{-1} märkäpainoa) kaksi- tai kolmevuotiaissa naarassilakoissa. Ennen vuotta 1998 mittaukset on tehty useammista yksilöistä yhdistetyistä lihasnäytteistä. Sen jälkeen tulokset ovat peräisin yksittäisten silakoiden mittauksista. Keskihajontatietoa ei ole käytettävissä.

Bild 6. Tidsserie för kvicksilverkoncentrationer (Hg, mg kg^{-1} våtvikt) i muskelvävnad hos två- eller treåriga honströmmingar. Före år 1998 gjordes mätningarna på muskelvävnad sammanslagen från flera individer, medan man därefter använt mätningar från indiviudella strömmingar. Uppgifter om standardavvikelser finns inte tillgängliga.

Table 1. Mean concentrations of harmful substances (organic substances: average concentration ± standard deviation µg kg^{-1} ww; metals: mg kg^{-1} ww) in two- and three-year-old herring of the HELCOM monitoring (all monitoring areas) in 2006 plus available food safety regulation limits NA = not available. ND = not detected. [a]) n = 2, [b] EU limit for fish, [c] Domestic limit for fish (EVIRA), [d] EU limit for mercury in fish tissue.

Taulukko 1. Haitallisten aineiden keskimääräiset pitoisuudet (orgaaniset yhdisteet: keskiarvo ± keskihajonta µg kg^{-1} märkäpainoa; metallit: mg kg^{-1} märkäpainoa) kaksi- ja kolmivuotiaissa silakoissa (HELCOM-seuranta) vuonna 2006 sekä saatavilla olevat elintarvikkeina käytettävien kalojen turvallisuusrajat. NA = ei saatavilla. ND = ei havaittu. [a] n = 2, [b] EU-raja-arvo kalalle, [c] kotimainen raja-arvo kalalle(EVIRA), [d] EU:n enimmäispitoisuusraja elohopealle kalan lihaksessa.

Tabell 1. Medelkoncentrationerna av skadliga ämnen (organiska föreningar: medelvärde ± standardavvikelse µg kg^{-1} våtvikt; metaller: mg kg^{-1} våtvikt) i två- och treåriga strömmingar år 2006 (HELCOM övervakning) samt tillgängliga gränsvärden för livsmedel. NA = inte tillgänglig, ND = inte detekterad. [a] n = 2, [b] EU-gränsvärde för fisk, [c] nationellt gränsvärde för fisk (EVIRA), [d] EU-gränsvärde för kvicksilver i muskelvävnad hos fisk.

Region	Kalajoki	Pori	Pori	Ahvenanmaa	Hanko	Hanko	Kotka	Safety limit
Age (y)	2	2	3	2	2	3	2	
Total DDT	0.7±0.3	1.0±0.3	0.7[a]	1.1±0.4	0.7±0.3	0.7[a]	0.9±1.9	50[b]
Total PCB	2.7±0.6	3.0±0.7	2.6[a]	3.1±1.0	2.5±0.6	2.5[a]	2.9±1.9	200[c]
α-HCH	ND	ND	ND	ND	ND	ND	ND	NA
γ-HCH	ND	ND	ND	ND	ND	ND	ND	100[c]
HCB	0.12±0.02	0.12±0.02	ND	0.16±0.02	ND	ND	ND	20[c]
Pb	0.03	0.06	0.04	0.04	0.04	<0.03	0.05	NA
Cd	0.326	0.558	0.440	0.436	0.392	0.531	0.300	NA
Cu	3.72	3.88	3.61	2.93	4.25	3.81	3.93	NA
Zn	28.1	18.1	15.4	17.8	17.6	22.1	21.7	NA
Hg	0.022	0.009	0.015	0.010	0.019	0.015	0.041	0.5[d]

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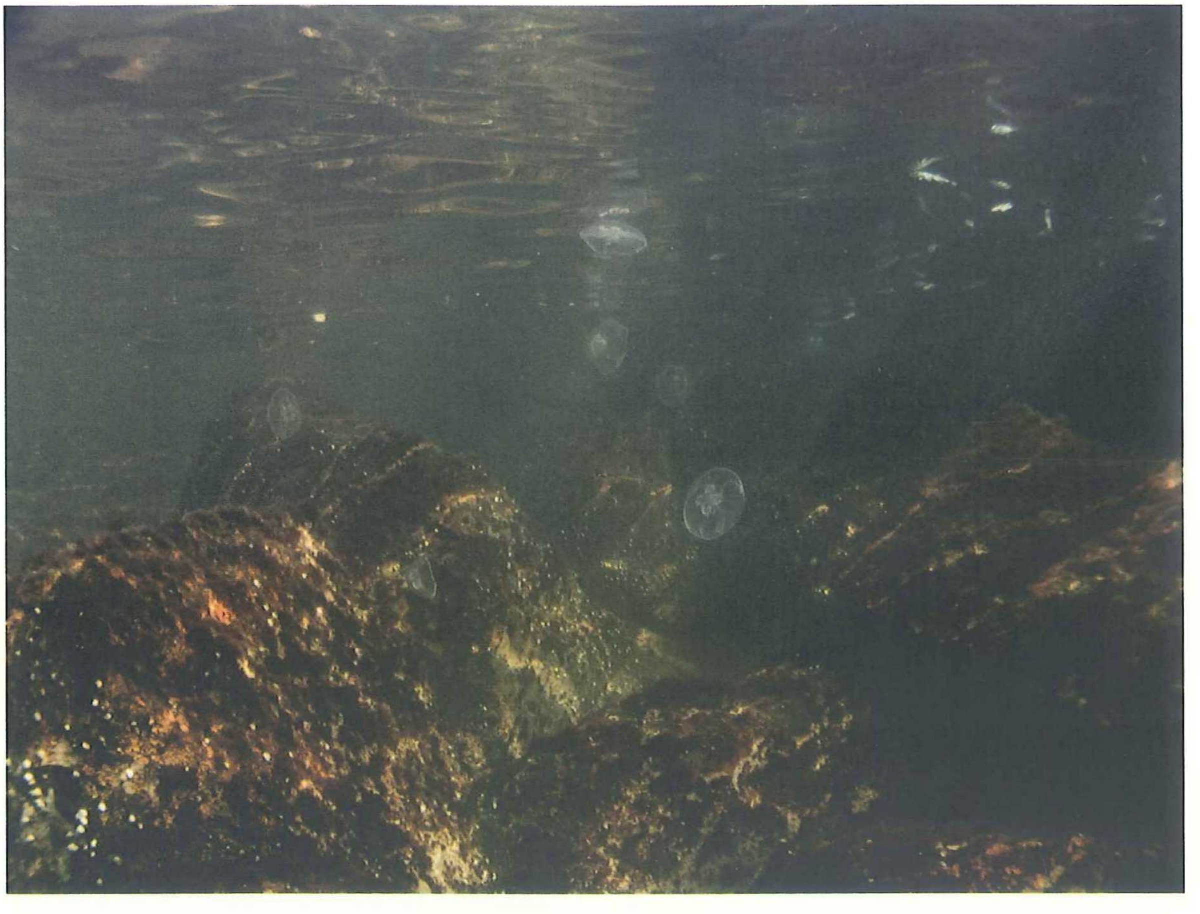

10. THE FIMR DATA PORTAL "HAVAINTOHAAVI"

Riitta Olsonen

Introduction

A new service to view and download Finnish marine area monitoring data is available at the FIMR web site. By registering as a user anybody can view the most essential FIMR monitoring data from sixteen monitoring stations that cover the whole Baltic Sea.

This web site, called "Havaintohaavi", enables simultaneous examination of observations as time series, seasonal variation and vertical profiles. The data can be downloaded free of charge directly from the site.

The Havaintohaavi user interface

The idea of the user interface is to allow dynamic data viewing and the gaining of a quick insight into the nature of the data; extreme values, for example, are easy to discover visually, identify interactively and study concurrently in the three dynamic views.

The user interface consists of a control panel and three data-viewing windows: a seasonal variation window, a time series window and a vertical profiles window (Fig. 1). The three data-view windows interact, so that if the user points to any observation in any window, the same observation is highlighted in the other windows. The location, time and exact value of an observation can be seen by pointing to it in any window.

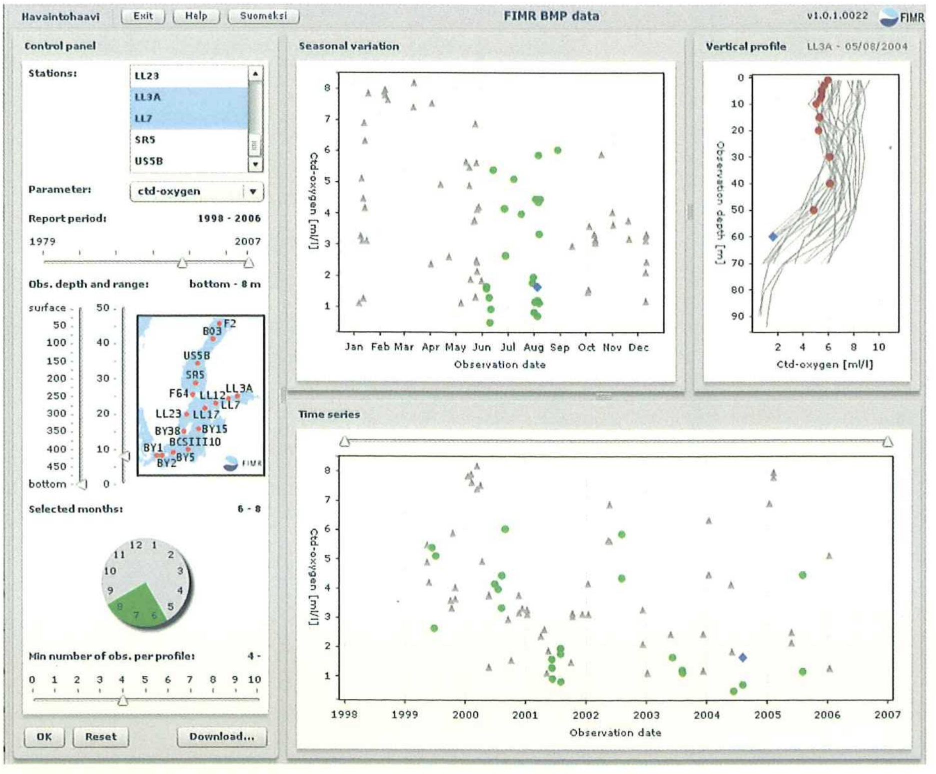

Fig. 1. The Havaintohaavi web interface.

Kuva 1. Käyttöliittymä Havaintohaavi.

Bild 1. Det webb-baserade användargränssnittet Havaintohaavi.

In the control panel (Fig. 2) the user can choose station(s), a parameter and a time span in years. In addition, the user can choose a desired depth or depth interval, and restrict the choice to specific months. In the vertical profiles window (Fig. 3), you may see the profiles of the chosen data by selecting the minimum number of measured values per profile in the control window.

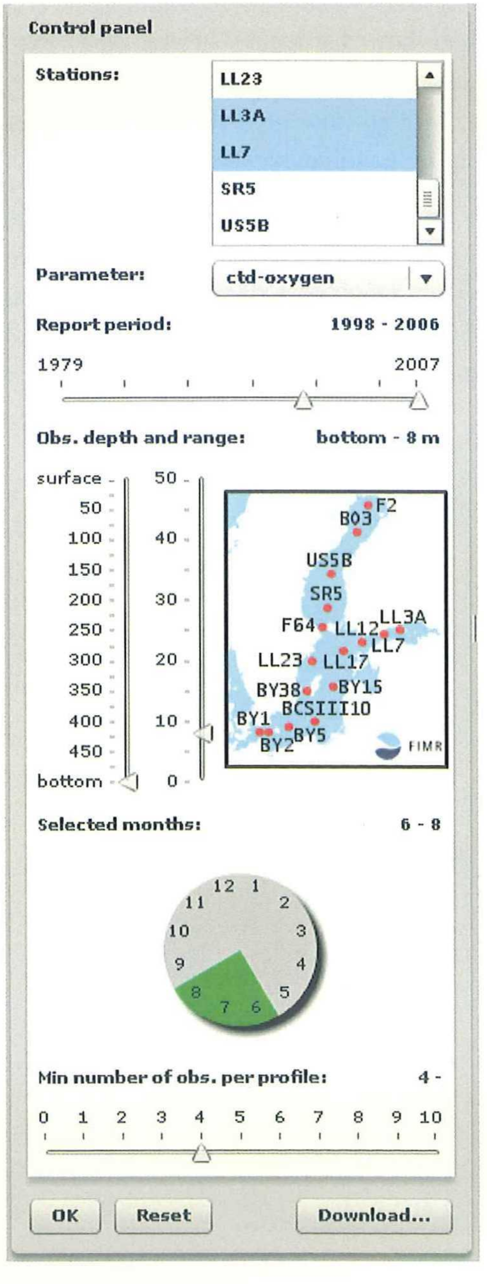

Fig. 2. The Havaintohaavi control panel.

Kuva 2. Havaintohaavin valintapaneeli.

Bild 2. Kontrollpanelen i Havaintohaavi.

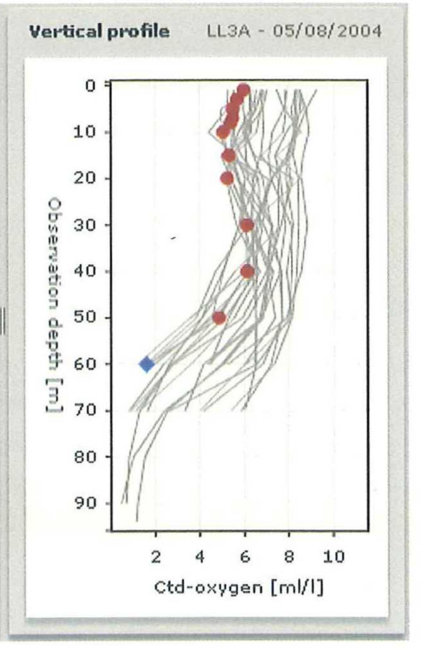

Fig. 3. The vertical profiles window.

Kuva 3. Syvyysprofiilien ruutu.

Bild 3. Fönstret för djupprofiler.

If the user has chosen an interval of some particular months in the control panel, the data for all the other months are shown as grey points, while the data for the selected months are highlighted (Figs. 4 and 5). The inspection period can also be selected in the time series window, which highlights the chosen years' observations in the seasonal variation window.

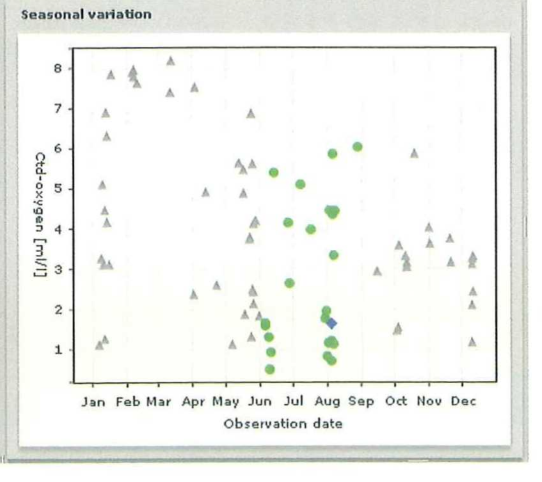

Fig. 4. The seasonal variation window.

Kuva 4. Vuodenaikaisvaihtelun ruutu.

Bild 4. Fönstret för årstidsvariationer.

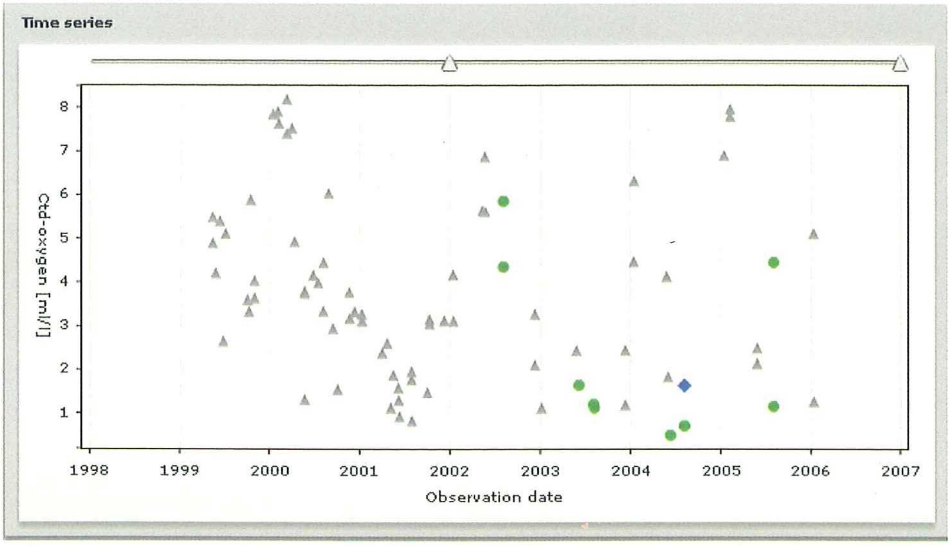

Fig. 5. The time series window.

Kuva 5. Aikasarjan ruutu.

Bild 5. Fönstret för tidsserier.

The data

The data set on this site consists of the most essential hydrographical and nutrients data of FIMR covering the whole Baltic Sea for the period 1979–2006. It includes more than 1700 visits to the sixteen stations (Fig. 6), and nearly 150000 observation values for the fourteen parameters of salinity, temperature, oxygen, phosphate, total phosphorus, silicate, nitrate-nitrite, nitrite, ammonium, total nitrogen, hydrogen sulphide, pH, chlorophyll-*a* and alkalinity.

FIMR is testing laboratory T040 (EN ISO/IEC 17025) accredited by FINAS, the Finnish Accreditation authority and the data in the web database fulfill the accreditation requirements from the year of the accreditation onwards.

These data, or a part of them, can be downloaded free of charge directly for one's own use. The user accepts the FIMR Data Policy and a "user license" that includes the giving of true contact information.

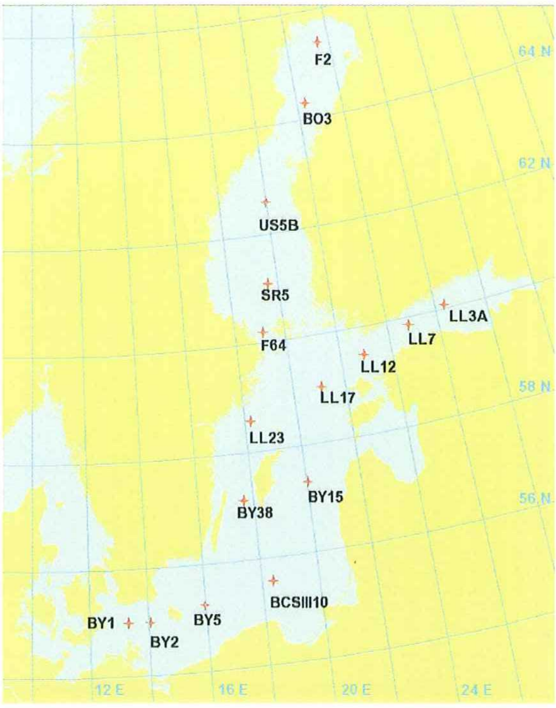

Fig. 6. The standard monitoring stations of the Finnish Institute of Marine Research.

Kuva 6. Merentutkimuslaitoksen tärkeimmät seurantapisteet Itämerellä.

Bild 6. Havsforskningsinstitutets viktigaste övervakningsstationer på Östersjön.

Visit the FIMR Data Portal Havaintohaavi at:

http://www.fimr.fi/en/palvelut/bmp/bmp-data.html.

FIMR

ISBN 978-951-53-3034-5 (nid.)
ISBN 978-951-53-3035-2 (PDF)

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ISSN 1238-5328